Sri Lanka Journal of Economic Research Volume 3 Number 2 December 2015

ISSN 2345-9913

S L J E R

Sri Lanka Journal of Economic Research

Volume 3 Number 2 December 2015

The International Journal of the Sri Lanka Forum of University Economists

Edited and Published on behalf of the SLFUE by
The Department of Economics,
University of Ruhuna,
Matara, Sri Lanka.

SRI LANKA JOURNAL OF ECONOMIC RESEARCH

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Volume 3 | **Number 2** | **December 2015**

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SRI LANKA FORUM OF UNIVERSITY ECONOMISTS

National Library of Sri Lanka – Cataloguing-In-Publication Data
SRI LANKA JOURNAL OF ECONOMIC RESEARCH
The International Journal of the Sri Lanka Forum of University Economists
Volume 3 Number 2 (2015)

ISSN 2345 – 9913

Published by the Sri Lanka Forum of University Economists
The Editorial Office (2014) of the SLJER
The Department of Economics, University of Ruhuna, Matara, Sri Lanka.
Telephone: + 94 041 22 22681/Ext.3202
Web: www.slfue.org
Email: ruh2014slfue@gmail.com

Editor (2014): A.J.M. Chandradasa

Printed by: **Printec Establishment Private Limited**
52/1, Ekwatta Road, Mirihana, Nugegoda, Sri Lanka
Telephone/Fax: +94 11 28 15 816
Web: www.printec.lk

Sri Lanka Journal of Economic Research

The International Journal of the Sri Lanka Forum of University Economists

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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.

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All articles in this journal are subject to a rigorous blind peer-review process initially, and are then reviewed by the editorial committee prior to final acceptance for publication.

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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

S L J E R

Sri Lanka Journal of Economic Research

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Volume 3 Number 2 December 2015

Sri Lanka Journal of Economic Research

Volume 3 *Number 2* *December 2015*

PANEL OF REVIEWERS

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AN INPUT-OUTPUT MODELING APPROACH AS AN EFFECTIVE DEVELOPMENT STRATEGY FOR SRI LANKA

RESEARCH ARTICLES
Sri Lanka Journal of Economic Research
Volume 3 (2)
December 2015: 3-30
Sri Lanka Forum of University Economists

SLJER

Chandika Gunasinghe

Abstract

This paper is aimed at measuring industrial interdependence using a symmetric input-output table complied for the Sri Lankan economy for 2006 to find an effective development strategy for the country. The input-output model is constructed for thirty aggregated industrial sectors of the economy as a whole. The output, value added and income multipliers reveal that there are five key industries of the Sri Lankan economy. These are: (1) recreational, cultural, sporting services and other services; (2) manufactured products of food, beverages and tobacco sector; (3) air transport services; (4) rubber & plastic products; and (5) metallic, non-metallic and mineral products. The employment multipliers are highest in: (1) real estate services; (2) electrical products; (3) petroleum & chemical products; and (4) rubber & plastic products industries. We found that five industries (sectors) have strong upstream and downstream vertical integrations with the rest of other sectors in the economy. The results reveal that higher prices charged on the petroleum & chemical products would probably result in higher costs to most of other sectors in the economy relatively equally. As 'mining and quarrying, electricity, gas and water' sector has strong downstream linkages to other sectors in the economy, higher prices (or taxes) charged on these products also result in higher costs to most of other sectors in the economy. The findings of the study reveal that prioritizing industries should be done based on an input-output analysis rather than just depending on the information provided by percentage of contribution in output and value addition to GDP by the sectors. However, the results should be interpreted very carefully as the impact of some sectors such as education difficult to be practically measured in monetary terms based on an input-output model.

Keywords: development planning, input-output model, industry multipliers, forward and backward linkages, Sri Lanka.

Chandika Gunasinghe
Senior Lecturer, Department of Economics, University of Ruhuna, Matara, Sri Lanka. Email: chandika.gunasinghe@griffithuni.edu.au

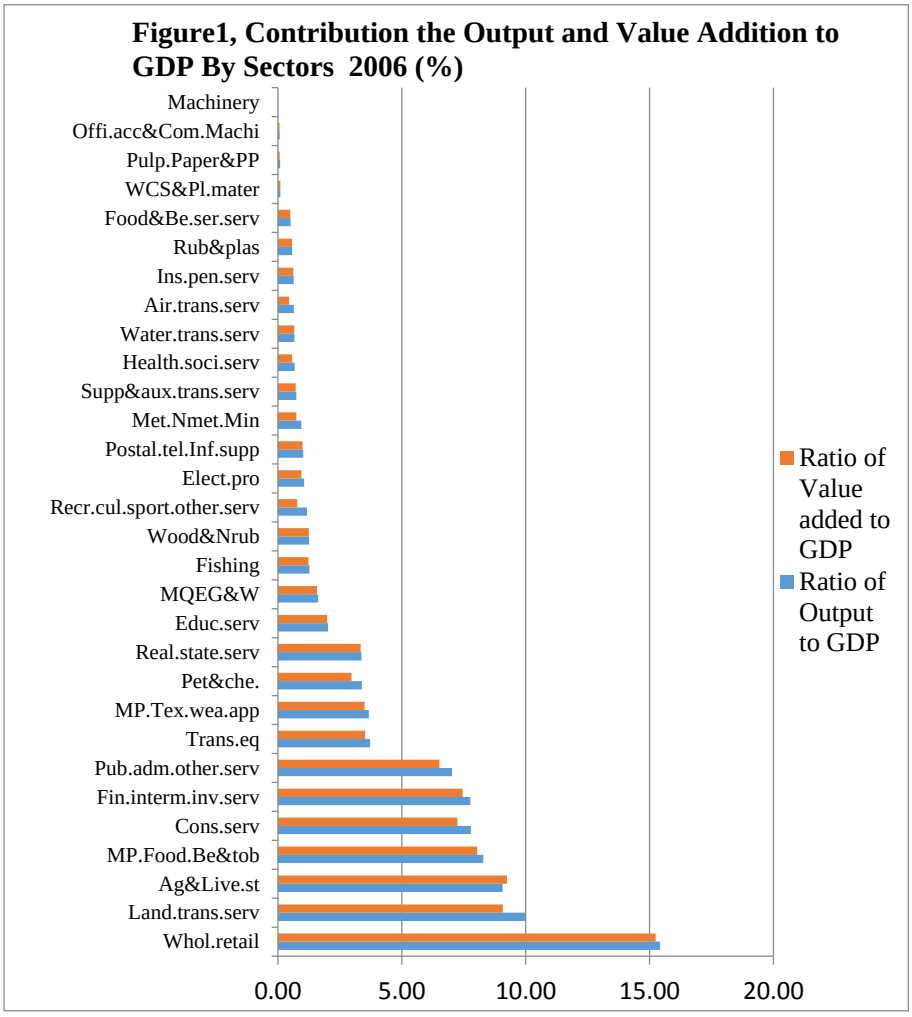
INTRODUCTION

A better understanding of the structure of a national economy is vital for the identification and implementation of an effective development strategy as it emphasizes the need of allocating more resources for sectors that generate more output, income, value-additions, employment, and have linkages with the domestic economy (Frédéric 2010). One of the best ways to develop this understanding is to "build a data base-model (an input-output model) of the economy which uncovers these underline structures and connections" leading to have a complete picture of the economy (Epstein et al 2010: pp 24-25; Frédéric 2010: pp 1). The multipliers (output, value added, income and employment) and linkage measures (upstream and downstream vertical integration of sectors) derived from an input-output model are considered as powerful tools that can be used to measure and assess national productive system and inter-sectoral relationships of an economy (Frédéric 2010).

The input-output model was developed by Professor Wassily Leontief in the late 1930s based on Walras' general equilibrium theory to data for the American economy. In recognition of his pioneering work, he was awarded by the Nobel Prize in Economic Science in 1973. As a result of this useful analytical innovation, researchers, policy analysts and practitioners have used (and still use) input-output models in economic impact analysis and economic development planning specially in the areas such as industrial, agricultural, environmental, energy, construction, transportation, tourism and educational sectors (Xinhao and Rainer 2007: pp 218-272). Miller and Peter (2009, p. 2) have pointed out that "Today, in the USA alone, input–output is routinely applied in national economic analysis by the US Department of Commerce, and in regional economic planning and analysis by states, industry, and the research community". Furthermore, Baumol (2000) considers input-output analysis as one of the most widely used applied methods in economics. However, the studies on the use of input-output models directed at policy related issues in Sri Lanka are, to some extent, limited. Rameezdeen, Zainudeen and Ramachandra (2005, 2008) examine the significance of the construction sector and its relationship between other sectors of the economy based on input-output tables compiled in the period from 1970 to 2000. They argue that construction sector is the key in the economy as the backward and forward linkage measures were significant (above average) in this sector out of forty-eight sectors of the economy in 2000.

Athukorala and Bandara (1989) examine the importance of using net-export earnings in measuring primary exports in the export structure and overall export growth by calculating a simple Leontief inverse using 1981 Input Output table (I-O table). Their findings reveal that using gross-export earnings leads to make misleading conclusions on the significance of export structure and its growth. Hazari and Bandara (1989) estimate linkage indices based on 1981 I-O table to look at the poverty impact in Sri Lanka an innovative way. Bandara and Kelegama (2008) provide an updated survey on the use of Input-output Tables (I-O Tables) and Social Accounting Matrices (SAMs) in Sri Lanka. Bandara (1990) provides a survey on the use of early I-O tables in Sri Lanka to develop CGE Models.

Figure1, Contribution the Output and Value Addition to GDP By Sectors 2006 (%)



Source: Author's calculation based on SIOT compiled by Bandara (2016)

The importance of the use of input-output model for development planning can be justified by inspecting Figure 1 given above. It shows the percentage of contribution made by each sector in terms of output and value addition to the GDP in Sri Lanka in 2006. Apparently, policy makers might misleadingly tend to identify the leading sectors of the economy as the sectors whose ratios of output and value added to GDP are high. Accordingly, they will allocate scare resources to boost sectors such as wholesale and retail trade services, land transport services, agriculture and livestock, manufactured products of food, beverages and tobacco, construction services, financial intermediation services and investment banking, and public administration and other services. However, it is crucial for an effective development policy to identify channels by which a growth of a sector such as mentioned above can support aggregate output, income, value addition and employment creation in the rest of the economy (Frédéric 2010). Therefore, it is essential to identify whether these "growth pulling" sectors have strong upstream and downstream vertical integrations with rest of the other sectors in the economy as it causes to generate high output, income, value added, and employment multipliers in these sectors. For example, a weak upstream vertical integration of a particular sector highlights the poor use of domestic factors of production, domestic inputs as well as capital and financial services for its own production, which in turn will make few opportunities not only for this sector but also for other sectors in the economy to generate additional output, income, value addition and employment avenues.

With this context, the aim of this study is to quantitatively measure and assess the industrial interdependence in Sri Lanka to draw policy relevant lessons to find an effective development strategy for the country. The study uses the data from the latest 2006 symmetric input-output table compiled by Bandara (2016) for Sri Lankan economy. The input-output model is constructed for thirty aggregated industrial sectors to have a better understanding of the underline structures and connections of the economy as a whole. We believe that this in turn will help policy makers to formulate an appropriate macroeconomic and sectoral policy to expand prioritized sectors that have strong upstream and downstream vertical integrations with the rest of the economy leading to generate a higher level of output, income, employment and value -added to the economy. The industry multipliers (output, value added, income and employment) and linkage measures (upstream and downstream) to the domestic economy are estimated using both "open" and "closed" (endogenizing households sector) versions of input-output model. All the calculations are done using Input-Output Software Version 1.0.1 (IOW).

The remainder sections of this paper are organized as follows. Section 2 presents the methodology of the study. Section 3 is about results and analysis. Section 4 presents concluding remarks. In Section 5, limitations of the study are given.

METHODOLOGY OF THE STUDY

As noted in the previous section, this study uses a symmetric input-output table (SIOT) for 30 sectors (industries) in the economy for the year 2006.

Table 1: Structure of the Symmetric Input-output Table Used in the Study

Industries / Products (outputs)			Industry 1	Industry 2	…	Industry 30	Final demand			Total prod. (demand)
							TFC	GCF	TE	
Intermediate inputs	Products of Industry 1		$x_{1,1}$	$x_{1,2}$	…	$x_{1,30}$	y_1			z_1
	Products of Industry 2		$x_{2,1}$	$x_{2,2}$	…	$x_{2,30}$	y_2			z_2
	...		…	…	…	…	…			…
	Products of Indust. 30		$x_{30,1}$	$x_{30,2}$	…	$x_{30,30}$	y_{30}			z_{30}
			(Intermediate usage)				(Final demand)			
Primary inputs	Final payments	C.E	ce_1	ce_2	..	ce_{30}	(Primary inputs to final demand)			**GDP (IA)**
		G.O.S	os_1	os_2	..	so_{30}				
		Net Tax	nt_1	nt_2	..	nt_{30}				
		Imports	m_1	m_2	---	m_{30}				
			(Primary inputs to production)							
Total production (supply)			q_1	q_2	…	q_{30}	**GDP (EA)**			
Employment			e_1	e_2	-	e_{30}				

Source: constructed based on ABS (2000, p.99) and SIOT complied by Bandara (2016).

The term 'symmetric' means that "the same classifications are used in both rows and columns" (ABS 2000, p. 95). Accordingly, the present study uses industry by industry calcification to make a square table that has industries in the columns and corresponding products in the rows. The Table 1 presents the structure of the SIOT used in the study, which clearly show how the transactions in an input-output table can be used to analytical purposes.

Where: C.E =compensation of employees; G.O.S = gross operational surplus; Net Tax= tax minus subsidies; TFC = total final consumption (government + private); GCF = gross capital formation (gross fixed capital formation +changes in inventory); TE = Total exports; DM =Demand; GDP (EA) = gross domestic product (expenditure approach); and GDP (IA) = gross domestic product (income approach).

Each row in Table 1 shows how the output of each industry is distributed among industries (including its own) and final demanders whereas each column shows the origin of inputs (both primary and intermediate) from other industries (including its own) and institutions into an industry. The row total for an industry is equal to the corresponding column total of the SIOT (that is $q_j = z_i$for all j,i = 1,2,…30) as the output of an industry must be equal to the value of total inputs used in the production process (ABS 2000, p.99). The core of SIOT is the inter-industry transaction matrix shown in the first quadrant (intermediate usage) where production relationships in the economy are depicted by the elements, x_{ij}. For example, element $x_{1,\ 30}$ shows how much output of 1st industry has been absorbed by 30th industry in its current production. Final demand category made up of elements y_i shows consumption behaviour of households, government, investors and exports. Final payment category includes basically two variables; value added (v_j) (the sum of C.E + G.O.S + Net tax) and imports. The value added vector shows contribution of each sector's to the GDP.

The data related to these three quadrants in the Table 1 can be conveniently presented using matrix algebra as follows:

$$z_i = \sum_{j=1}^{30} x_{ij} + y_i \qquad (1)$$

$$q_j = \sum_{i=1}^{30} x_{ij} + ce_j + gos_j + nt_j + m_j \qquad (2)$$

Where: z_j in (1) is the total demand for output of i^{th} industry and q_j in (2) is the total supply of j^{th} industry; x_{ij} are sales by sector i to sector j; the row sum of x_{ij} in equation (1) shows the total value of sales of industry i to all industries (including sales of industry i as well); the column sum of x_{ij} in equation (2) is the total value of purchases done by industry 'j' from all other 'i' industries (including purchases of output of industry 'j' as well) in the economy.

The next step is to obtain the direct input-output coefficients matrix A that is made up of elements (a_{ij}). The matrix A is obtained by dividing the elements in the industry transaction matrix (x_{ij}) from respective column totals, q_j. That is,

$$a_{ij} = \frac{x_{ij}}{q_j} \tag{3}$$

Hence,

$$a_{ij} q_j = x_{ij} \tag{4}$$

Substituting $a_{ij} q_j$ for x_{ij} and q_j *for* z_i (on the condition that output of an industry must be equal to the value of total inputs used in the production) in equation (1) yields the following equation:

$$q_j = \sum_{j=1}^{30} a_{ij} q_j + y_i \tag{5}$$

This is just for one sector and for 30 sectors this can be shown in a matrix form considering q_j and y_i represent 30 by 1 output and 30 by 1 final demand vectors respectively. Hence, it takes the form;

$$q_{j(30x1)} = A_{(30X30)} q_{j(30x1)} + y_{i(30x1)} \tag{6}$$

The elements, a_{ij} , in the direct requirement matrix A represent the direct inputs requirements from sector i per 1 million LKR (as the data are given in LKR millions) worth of final demand for the output of industry j.

Rearranging equation (6), open total requirement matrix (Leontief inverse matrix) can be obtained as follows;

$$q_{j(30x1)} = (I - A_{(30X30)})^{-1} y_{i(30x1)} \quad (7)$$

or $$q_{j(30x1)} = B_{(30X30)} y_{i(30x1)} \quad (8)$$

Now the elements, b_{ij} , in the open total requirement matrix B in equation (8) represents the direct and indirect inputs requirements from sector i per 1 million LKR worth of final demand for the output of industry j. Following the same method, but the row vector related to the household sector (compensation of employees) in the primary input matrix and the column vector of household consumption in the final demand matrix are putting into the industry transaction matrix (x_{ij}), closed total requirement matrix is obtained as follows;

$$q^{*}_{j(31x1)} = B^{*}_{(31x31)} y^{*}_{i(31x1)} \quad (9)$$

Both the B in (8) and B^{*} in (9) matrices are powerful tools that are used to measure the total impact on the economy for changes in final demand vector y. Furthermore, these matrices are also used to derive (open and closed) multipliers (output, value added, income and employment) and (open and closed) the linkage measurers.

Now the elements, b^{*}_{ij} , in the closed total requirement matrix B^{*} in equation (9) represents the direct, indirect and consumption induced inputs requirements from sector i per 1 million LKR worth of final demand for the output of industry j. The inclusion (endogenized) of the household sector in the industry transaction matrix is more realistic due to the fact that any increase in income generated from direct and indirect expansion of the level of production in the economy and in turn cause an increase in consumption.

The size of the elements of B^* are larger than that of B due to the impact of consumption induced demand on the level of output. That is, all sectors are required to generate increased output levels to meet the consumption induced demand in the economy. Because of this reason, Type II multipliers are always larger than that of Type I multipliers. However, Miller and Blair (2009, 253) highlighted that "it is generally conceded that Type I multipliers probably underestimate economic impacts (since household activity is absent) and Type II multipliers probably give an overestimate (because of the rigid assumptions about labour incomes and attendant consumer spending)". Miller and Blair (2009, 253) further noted that "some in between figure might be more realistic but deciding exactly where these two limits may be problematic". Therefore, when industries are ranked based on the size of the multipliers to identify key sectors in the economy, both Type I and Type II multipliers are employed.

Deriving Multipliers

Multipliers are used to estimate the effects of exogenous changes in the final demand vector $\Delta y_i \ or \ \Delta y_i^*$ on: (a) outputs expected to be generated at each sectors in the economy; (b) income expected to be earned by households in each sector because of the new outputs; (c) employment (jobs, in physical terms) expected to be generated in each sector because of the new outputs; and (d) the value added expected to be created by each sector in the economy because of the new outputs (Miller and Peter 2009, p. 244).

Output multipliers for both open and closed models

It is clear that the elements $b_{ij} \ (or \ b_{ij}^*)$ in the matrix B (or B^*) are industry to industry multipliers combining final demand for the output of industry ' j' to output of industry 'i'. This can be explained using equation (8) or (9);

$$\Delta q_{j(30x1)} = B_{(30X30)} \Delta y_{i(30x1)}$$

$$\begin{bmatrix} \Delta q_1 \\ \Delta q_2 \\ . \\ . \\ \Delta q_{30} \end{bmatrix} = \begin{bmatrix} b_{1,1} & b_{1,2} & \ldots & b_{1,30} \\ b_{2,1} & b_{2,2} & \ldots & b_{2,30} \\ . & & & \\ . & & & \\ b_{30,1} & b_{30,2} & \ldots & b_{30,30} \end{bmatrix} \begin{bmatrix} 1 \\ 0 \\ . \\ . \\ 0 \end{bmatrix} = \begin{bmatrix} b_{1,1} \\ b_{2,1} \\ . \\ . \\ b_{30,1} \end{bmatrix} \quad (10)$$

This shows that increase of LKR one million worth of final demand ($\Delta y_i = 1$) results to increase the volume of $b_{1,1}$ output in the industry one itself, $b_{2,1}$ output increase in industry 2 etc. Unlike the sector to sector multipliers, output multipliers (column sums of B or B^*) are industry to economy multipliers combining final demand for the output of industry 'j' to economy wide output (Miller and Peter 2009, p. 246).

Output multiplier for the open model:

$$Type\ I\ \ Mult_{output}(j) = i' \Delta q_j = \sum_{i=1}^{30} b_{ij} \quad where\ i'_{(1x30)} = (1,1,.....1)$$

(11)

Therefore, the output multiplier for industry 'j' is the sum of column 'j' in B matrix over all industries from i =1 to i=30. For example, this means that LKR one million worth of final demand ($\Delta y_i = 1$) for the output of industry one has created LKR $\sum_{i=1}^{30} b_{i1}$ worth of output in the economy. That is the value of the total output generated by all sectors (including the sector one output) in the economy to meet LKR one million worth of demand for output in industry one is the summation of the first column in the matrix B

Output multiplier for the original 30 sectors based on the closed model:

$$Type\ II\ \ Mult_{output}(j) = i^{/}\Delta q_j^{*} = \sum_{i=1}^{30} b_{ij}^{*} \quad where\ i_{(1x30)}^{/} = (1,1,.....1)$$

(12)

Income Multiplier

Combining the output multiplier (equation 11 or 12) with technical coefficient for income (employee compensation) output ratio, income multiplier can be derived as follows;

$$Type\ I\ \ Mult_{income}(j) = \sum_{i=1}^{30} (\frac{ce_j}{q_j})_i b_{ij} \qquad (13)$$

Income multiplier for the original 30 sectors based on the closed model:

$$Type\ II\ \ Mult_{income}(j) = \sum_{i=1}^{30} (\frac{ce_j}{q_j})_i b_{ij}^{*} \qquad (14)$$

Income multiplier for industry 'j' measures the total value of household income generated from all the sectors in the economy when producers increase their productions to meet the LKR one million worth of final demand for the output of industry 'j'.

Value added multiplier

The value added multiplier can be derived by combining the output multiplier (equation 11 or 12) with technical coefficient for value added (v_j) output ratio. Then,

$$Type\ I\ \ Mult_{VA}(j) = \sum_{i=1}^{30} (\frac{v_j}{q_j})_i b_{ij} \qquad (15)$$

Value added multiplier for the original 30 sectors based on the closed model:

$$Type\ II\ \ Mult_{VA}(j) = \sum_{i=1}^{30} (\frac{v_j}{q_j})_i b_{ij}^* \qquad (16)$$

Value added multiplier for industry 'j' measures the total value additions by each sectors in the economy when they increase their productions to meet the LKR one million worth of final demand for the output of industry 'j'.

Employment Multiplier

Combining the output multiplier (equation 11 or 12) with technical coefficient for employment (e_j) output ratio, employment multiplier is derived as follows;

$$Type\ I\ \ Mult_{EM}(j) = \sum_{i=1}^{30} (\frac{e_j}{q_j})_i b_{ij} \qquad (17)$$

Employment multiplier for the original 30 sectors based on the closed model:

$$Type\ II\ \ Mult_{EM}(j) = \sum_{i=1}^{30} (\frac{e_j}{q_j})_i b_{ij}^* \qquad (18)$$

Employment multiplier for industry 'j' measures the total number of employment opportunities generated in all the sectors in the economy when they increase their productions to meet the LKR one million worth of final demand for the output of industry 'j'.

Based on the multipliers (Type I and II) derived above, the significance of industries on the overall economic performance (leading sectors) is determined based on the criterion that average value of both Type I and Type II multipliers for each industry should be above its overall average (Raufdeen et al 2005). This criterion is justifiable as its value always lays in between both Type I and Type II multipliers. However, the sizes of the multipliers depend on the degree that the upstream and downstream vertical integrations of the sectors with the rest of the other sectors in the economy. This will be discussed in the following section.

Derivation of the backward and forward linkages

Based on the data of input-output model, it is possible to measure two kinds of economic effects of an industry effects on other sectors of the economy. First, if industry 'j' expands its production, it does mean that the industry 'j' will demand more outputs from other sectors as inputs for its production. This kind of interconnection of industry 'j' with other sectors is called a "backward linkage" that captures the interconnectedness of this sector with upstream industries (sectors from which sector 'j' purchases inputs) in the economy (Miller and Blair 2009, p.555). Second, increase the output of industry 'j' also means that there are additional outputs (supply) in industry 'j' that can be used for other sectors as inputs for their own productions. This kind of interconnection of industry 'j' with other sectors in the economy is called a "forward linkage" that captures the interconnectedness of this sector with downstream industries to which sector 'j' sells its output.

Backward linkage for each 30 sectors based on the open model:

$$BL(j) = i^{/} B = \sum_{i=1}^{30} b_{ij} \quad where\ i^{/} = (1,1,.....1) \qquad (19)$$

Forward linkage for each 30 sectors based on the open model:

$$FL(i) = B.i \ = \sum_{i=1}^{30} b_{ij} \quad where\ i \ = (1,1,.....1)^{/} \qquad (20)$$

Relevance of linkage measures for policy making is very high compared to that of multipliers. Miller and Blair (2009, p.555) note that "comparisons of the strengths of backward and forward linkages for the sectors in a single economy provide one mechanism for identifying "key" or "leading" sectors in that economy (those sectors that are most connected and therefore, in some sense, most "important")".

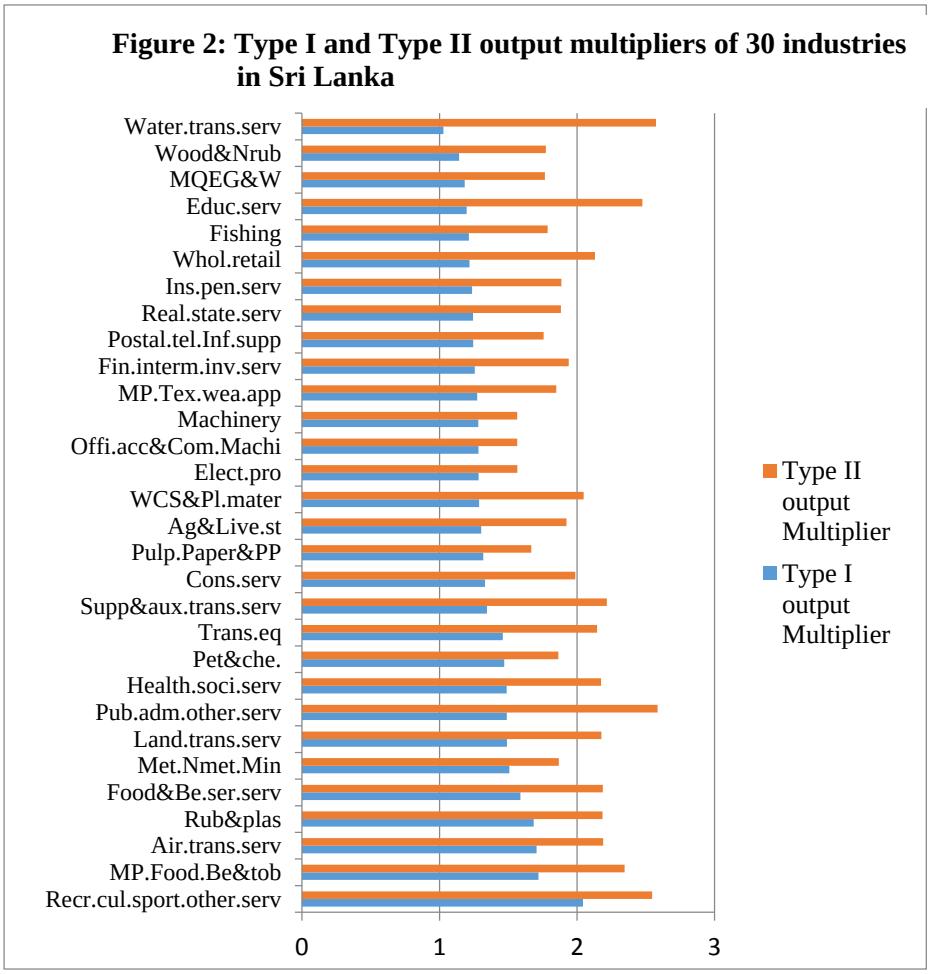
Therefore, a sector is identified as a key industry in the economy if the measures in both the backward and forward linkages are greater than one. Backward and forward linkages are normalized to one such that the estimated values of each linkage related to a sector above one, means that

the sector is above average heavily dependent on domestic sectors for its input requirements (backward oriented) and domestic sectors that are above the average dependent are in question for their input requirements (forward oriented) respectively (Gravino 2012).

RESULTS AND ANALYSIS

To begin, it is worthy to present the analysis of results obtained for multipliers in first.

Figure 2: Type I and Type II output multipliers of 30 industries in Sri Lanka



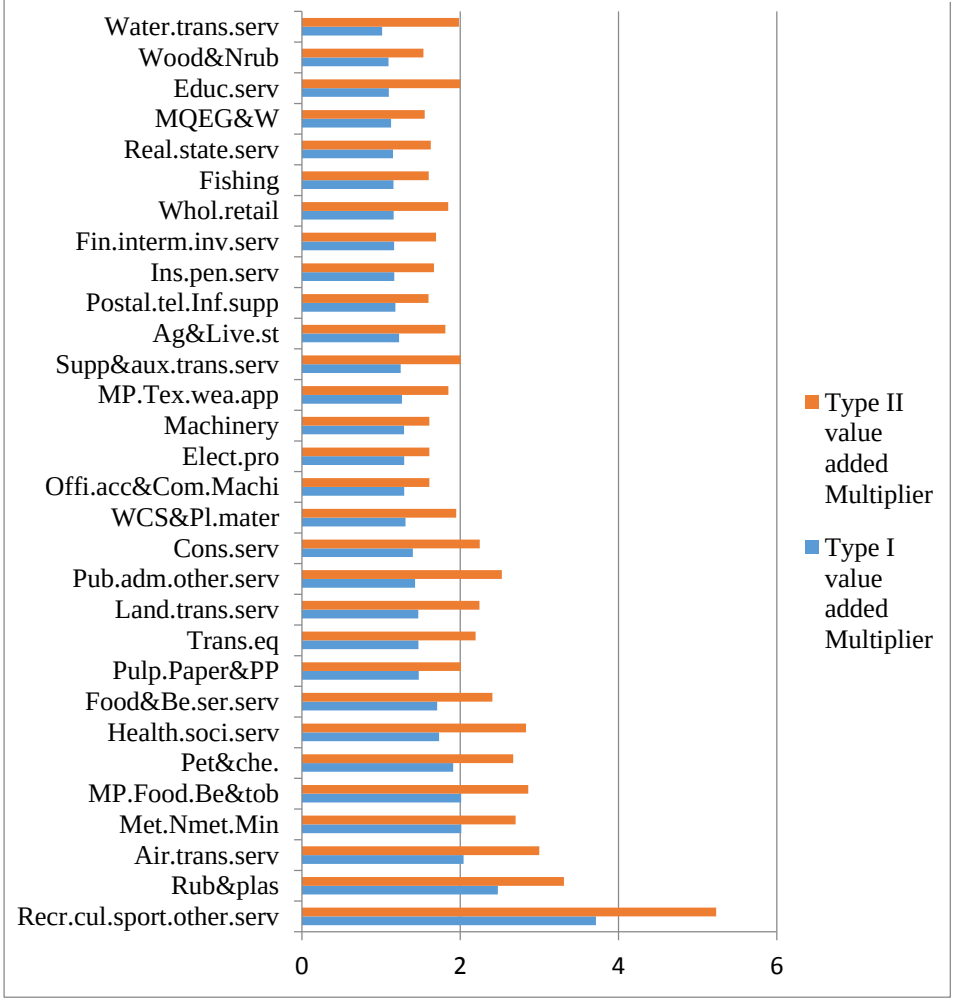
Source: Author's calculation based on SIOT compiled by Bandara (2016).

Figure 2 shows the relative contribution of each industry to economy wide output based on the ranking of Type I output multiplier. As it was expected, Type II multipliers are always larger than its Type I counterpart implying that each industries produces an increased amount of output in the economy to meet the consumption induced demand. Figure 2 reveals further that output multipliers for 30 sectors, meaning that LKR one million worth of increase in the demand for any sector's output would generate LKR one million worth plus some additional value of output in the economy. The largest output multiplier (Type I is 2.0 and Type II is 2.5) is reported from 'recreational, cultural, sporting services and other services'.

This means that LKR one million worth of final demand for the output of this industry would generate LKR 1 million and LKR 1.5 million worth of additional output in the economy. The second largest output multiplier (ranked based on Type I) is reported from 'manufactured products of food, beverages and tobacco sector' followed by 'air transport services' etc. The water transport service sector reports the lowest output multiplier of which the value of Type I is 1.03 whereas the value of Type II is 2.57 implying that LKR one million worth of final demand for the output of this industry would generate LKR 0.03 million and 1.57 million worth of additional output in the economy. One of the striking features that can be observed in Figure 2 is that the values of Type II multipliers are relatively higher for 3 sectors as; public administration and other services, education services, and water transport services. The reason for the presence of these higher values can be explained with the fact that the sectors are more labour incentive compared to other sectors resulting high consumption induced impacts.

Figure 3 shows the relative contribution of each industry to economy wide value addition based on the ranking of Type I value added multipliers. Figure 3 reveals that the value added multipliers for 30 sectors are above one, meaning that LKR one million worth of increase in the demand for any sector's output would generate a total impact on the country's GDP which is greater than LKR one million. The largest value added multiplier (Type I is 3.72 and Type II is 5.23) is reported from 'recreational, cultural, sporting services and other services' which means that LKR one million worth of final demand for the output of this industry would generate LKR 2.72 million and 4.23 million worth of additional value added in the economy. The second largest multiplier (ranked based on Type I) is reported from 'rubber & plastic products', followed by 'air transport services', and then 'metallic, non-metallic and mineral products', followed by 'manufactured products of food, beverages and tobacco sector' so on respectively.

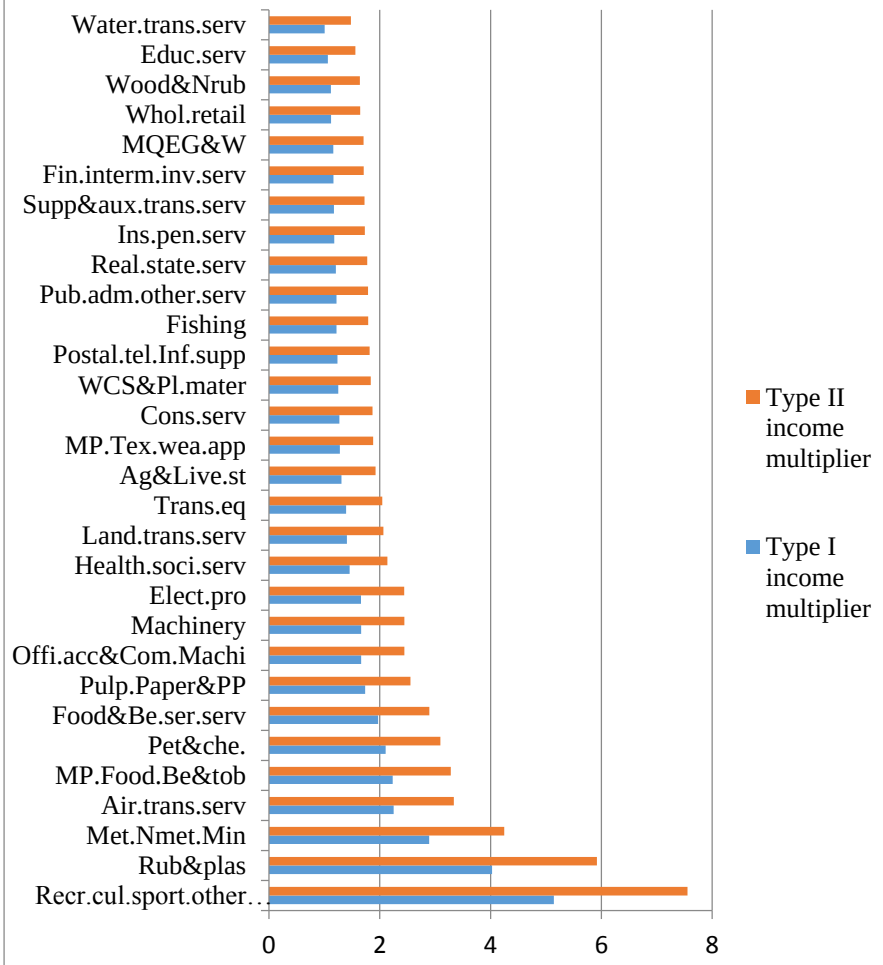
Figure 3: Type I and Type II Value Added Multipliers of 30 Industries in Sri Lanka



Source: Author's calculation based on SIOT compiled by Bandara (2016).

The water transport service sector reports the lowest valued added multiplier of which the value of Type I is 1.01 and Type II is 1.98 implying that LKR one million worth of final demand for this industry would generate LKR 0.01 million and .98 million worth of additional value added in the economy.

Figure 4: Type I and Type II Income Multipliers of 30 Industries in Sri Lanka

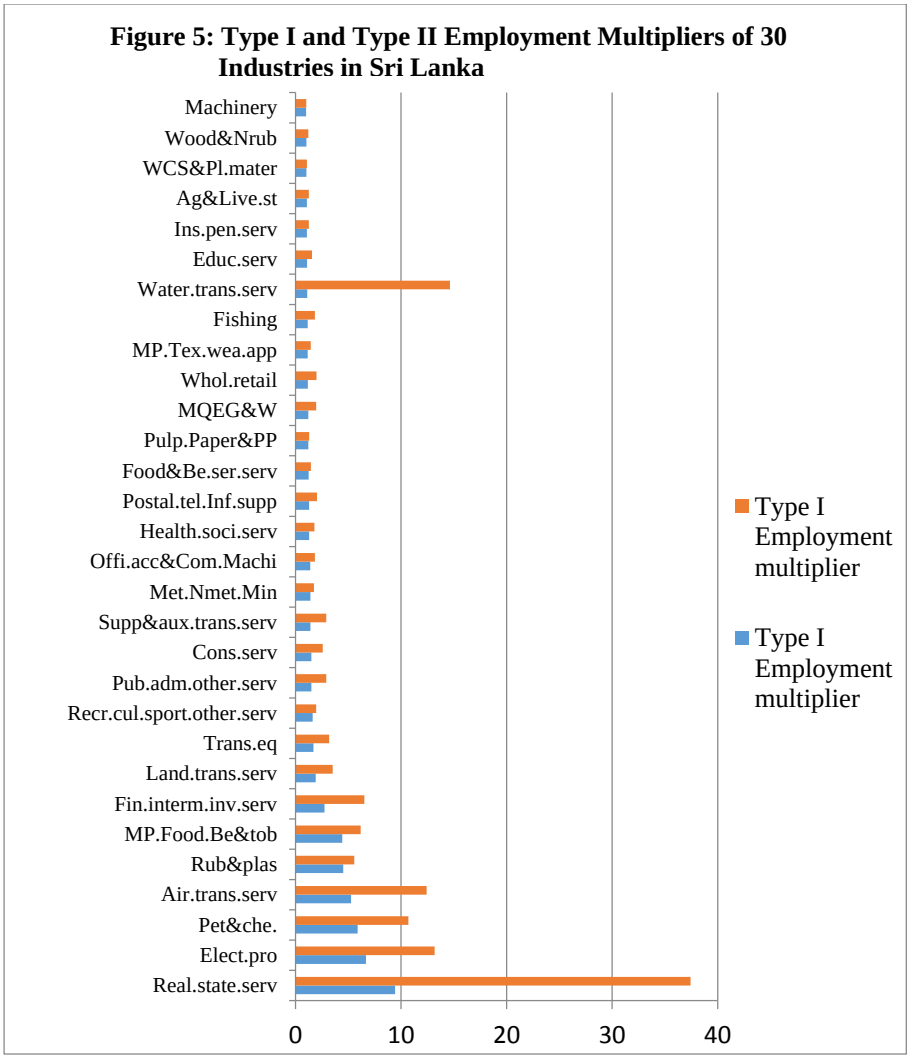


Source: Author's calculation based on SIOT compiled by Bandara (2016).

Information are in Figure 4 shows the relative contribution of each industry to economy wide income (compensation of employees) based on the ranking of Type I income multiplier. Figure 4 further reveals that income multipliers for 30 sectors are above one, meaning that LKR one million worth of increase in the demand for any sector's output would generate LKR one million worth plus some additional labour income in the economy. It is highest in sectors such as 'recreational, cultural, sporting services and other services', 'rubber & plastic products' followed by 'air transport

services', and then 'metallic, non-metallic and mineral products', and then 'manufactured products of food, beverages and tobacco sector' so on respectively. It means that all these five sectors are relatively labour incentive reflecting that high ratio of wages to total output of those sectors. The sectors such as 'water transport service', 'education services', 'wood & natural rubber', and 'wholesale and retail' have low income multipliers which reflect the fact that their wage shares in total industry output are at low levels

Figure 5: Type I and Type II Employment Multipliers of 30 Industries in Sri Lanka



Source: Author's calculation based on SIOT compiled by Bandara (2016).

Figure 5 depicts the relative contribution of each industry to economy in respect of employment generation, based on the ranking of Type I employment multiplier. The employment multipliers are highest in the sectors: real estate services, electrical products, petroleum & chemical products, and rubber & plastic products industries. According to the Type I (Type II) employment multipliers, a total of 9(37), 7(13), 6(11), and 5(12) new employment opportunities would be in the economy as a result of increasing the LKR one million worth of output in these industries.

The direct coefficient matrix (not shown here) shows that the ratio of employment to gross output is lowest (less than one) in these sectors implying that any expansion of their production would have a high potential of generating relatively a larger number of additional job opportunities. The lowest employment opportunities are reported from 22 sectors (out of 30) where the Type I employment multipliers are at around one. It means that expansion of the production of each industry by LKR one million would possibly only to generate one employment opportunity in the economy. The striking feature that can be observed from this analysis is that the ratios of employment to gross output in these industries are ranking above one and it means that they are running at full capacity of labour on the one hand and an expansion of the production of these sectors would have the less potential of generating additional job opportunities on the other. For example, the ratio of employment to gross output in machinery sector is at around 40. This means that each additional LKR one million worth of output in this sector will create a forty employment opportunities. As a result of this higher labour incentive technology, machinery sector has the lowest employment multiplier (Type I is 1.01 and Type II is 1.02) out of all the sectors (see Figure 5). These findings suggest a necessity of adopting the appropriate policies into these sectors to improve the productivity for an expansion of these sectors and to generate additional employment opportunities in the future.

Another important finding found in this study is that, as it was expected, the Type II multipliers have always been high compared to its Type I counterpart. It is natural for the Type II multipliers to have large values as it is assumed that the household sector is neither imposed taxes nor they save money from their wages. Therefore, as explained before, Type II multipliers captured by direct, indirect and consumption induced impacts tend to overestimate the true multipliers while it's Type I counterpart captured by direct and indirect impacts tend to underestimate the true multipliers. Thus, any value between the values of these two multipliers can be expected to show a realistic picture.

Table 2: Identification of Leading Sectors in the Economy (Based on Estimated Output Multipliers)

Industry	Average output Multiplier [(Type I + II)/2]	Rank based on average output multiplier
Recreational, cultural, sporting services and other services	2.29	1
Public administration and other services to the community as a whole	2.04	2
Manufactured products of food, beverages and tobacco	2.03	3
Air transport	1.95	4
Manufacture of Rubber & Plastic Products	1.94	5
Hotel and restaurants	1.89	6
Education	1.84	7
Land transport; transport via pipelines	1.83	8
Health and social work	1.83	9
Transport equipment	1.80	10
Water transport	1.80	11
Supporting and auxiliary transport activities; activities of travel agencies	1.78	12
Average output multiplier (Type I and II) for 30 sectors	**1.70**	

Source: Author's calculation based on SIOT compiled by Bandara (2016).

As can be seen in Table 2, 12 sectors are only satisfied with the criteria that designed to identify the key sectors in the economy. The highest average output multiplier (2.29) is reporting from the sector called recreational, cultural, sporting services and other services. For example, increase of LKR one million worth of output for final demand in this sector would generate an additional LKR 1.29 million worth of output in the economy. The second leading sector in the economy is 'the public administration and other services to the community' followed by 'manufactured products of food, beverages and tobacco' and then air transport so on. In the ranking of key sectors in the economy, the education and health sector rank at 7^{th} and 9^{th}

places respectively. The significance of these sectors to generate the output in the economy mainly rooted from the consumption induced impact.

Table 3: Identification of Leading Sectors in the Economy (Based on Estimated Value Added and Income Multipliers)

Industry/Sectors	Value added multipliers		Income multipliers	
	Average (Type I +Type II)/2	Rank	Average (Type I + Type II)/2	Rank
Recreational, cultural, sporting services and other services	4.47	1	6.35	1
Manufacture of Rubber & Plastic Products	2.90	2	4.97	2
Air transport	2.52	3	2.79	4
Manufactured products of food, beverages and tobacco	2.44	4	2.76	5
Health and social work	2.42	5	-	12
Manufacture of metallic, non-metallic and mineral products	2.33	6	3.57	3
Petroleum & chemical products	2.20	7	2.60	6
Public administration and defence; compulsory social security	2.12	8	-	21
Hotels and restaurants	1.94	9	2.43	7
Construction	1.86	10	-	17
Land transport; transport via pipelines	1.86	11	-	13
Manufacture of paper and paper products & Printing	-	13	2.15	8
Average value added and income multipliers for 30 sectors	**1.85**		**2.08**	

Source: Author's calculation based on SIOT compiled by Bandara (2016).

Table 3 shows that the ranking of leading sectors based on the average values of both the value added and income multipliers. Accordingly, the highest average value added and income multipliers are reported from 'recreational, cultural, sporting services and other services' and then followed by 'manufacture of rubber & plastic products'. Hence, these two sectors deserve to consider as leading sectors of Sri Lankan economy. The average value added multiplier of 'manufacture of paper and paper products & printing' is lower than its overall average value and it is greater than in case of overall average value of income multiplier. This implies that this sector is the leading sector in terms of impact of income multiplier. According to the value added multipliers along, four key sectors can be identified in the economy. These are the: health and social work; public administration and defence; construction; and land transport. In the case sector's contribution to the value addition, these sectors would be given priority in allocating resources to expand their capacity.

Table 4: Identification of Leading Sectors in the Economy (Based on Estimated Employment Multipliers)

Industry/Sector	Average employment Multiplier (Type I and II)/2	Rank based on average employment multiplier
Real estate activities	23.43	1
Manufacture of electric motors & electrical equipment	9.93	2
Air transport	8.84	3
Manufacture of petroleum & chemical products	8.29	4
Water transport	7.88	5
Manufactured products of food, beverages and tobacco	5.30	6
Manufacture of rubber & plastic products	5.04	7
Financial intermediation and investment banking	4.63	8
Average employment multiplier (for 30 sectors	**3.62**	

Source: Author's calculation based on SIOT compiled by Bandara (2016).

Table 4 ranks the key sectors based on the values of average employment multipliers. By contrast to the ranking of sectors based on the output, value addition and income multipliers, the real estate activities become the leading sector of the economy in terms of generation of employment opportunities. The second key sector is the 'manufacture of electric motors & electrical equipment' and then 'air transport followed by manufacture of petroleum & chemical products' so on. It is worthy to note that some sectors become key sectors in terms of output, value addition and income multipliers however, less important in terms of generation of employment opportunities in the economy. Such type of sectors are: recreational, cultural, sporting services and other services; public administration and defence; health and social work; manufacture of metallic, non-metallic and mineral products; petroleum & chemical products; construction sector; land transport; and lastly manufacture of paper and paper products & printing sector.

Linkage analysis

The results presented in Table 5 show that there are five industries (sectors) which have strong upstream and downstream vertical integrations with the rest of the other sectors in the economy. These sectors are: (1) recreational, cultural, sporting services and other services, (2) manufacture of rubber & plastic products, (3) hotels and restaurants, (4) manufacture of metallic, non-metallic and mineral products, and (5) petroleum & chemical products respectively. The sectors with strong upstream and downstream linkages with other industries mean that they not only utilize a large amount of domestically produced outputs as inputs in their production processes but also their outputs are used in a greater extent by other sectors in the economy as inputs to produce final goods and services. Based on the results of average coefficient of variations (not shown here) with regard to backward and forward linkages, it is found that relatively low variations are reported from sector 5, sector 3 and sector 1 respectively. This implies that the stimuli generated by investment in these three sectors are relatively evenly shared amongst all sectors in the economy. As the lowest average coefficient of variation is reported from the sector called petroleum & chemical products, higher prices charged on products such as petrol, diesel etc. in this sector would probably result in higher costs to most other sectors in the economy relatively equally.

Table 5: Identification of Key Industries in Sri Lanka (Based on the Backward and Forward Linkage Measures)

Criteria	Industries/Sectors	**Decision**
Both backward linkage (BL) and forward linkage measures (FL) >1	Recreational, cultural, sporting services and other services Manufacture of rubber & plastic products Hotels and restaurants Manufacture of metallic, non-metallic and mineral products Petroleum & chemical products	**Generally dependent**
BL >1 but FL < 1	Manufactured products of food, beverages and tobacco Air transport Health and social work Transport equipment Land transport; transport via pipelines Public administration and other services to the community as a whole	**Dependent on inter-industry supply**
FL>1 but BL < 1	Manufacture of products of wood, cork, straw and plaiting materials Agriculture & Livestock Machinery Financial intermediation services, and investment banking, Insurance and pension services Mining and quarrying, electricity, gas and water Forestry: wood & natural rubber	**Dependent on inter-industry demand**
Both BL and FL < 1	Construction Manufacture of paper and paper products & printing Manufacture of electric motors & electrical equipment Manufacturing of textile and wearing apparel Real estate activities Post and telecommunications Wholesale and retail trade Fishing Education Water transport Supporting and auxiliary transport activities; activities of travel agencies Manufacture of office, accounting and computing machinery	**Generally, independent**

Source: Author's calculation based on SIOT compiled by Bandara (2016).

Therefore, these sectors could be considered leading sectors in the economy as they are most connected with all industries in such a way that their output, employment, and value added multipliers would be influenced by strong domestic linkages, although other sector-specific factors such as the use of imported inputs, labour intensity of production, technology, and the level of productivity could also influence the size of these multipliers. For example, sector 4 and 5 mentioned above have relatively strong upstream and downstream linkages to other industries. However, as these sectors use more than one thirds of imported inputs (about 33% and 34% respectively) in their production process, this will reduce the domestic impact of these sectors on the Sri Lankan economy. A less dependency on imported inputs is reported from sector 3 (5.1%), sector 2 (6.2%) and sector 1(13%). As a result, the domestic impacts of these sectors on the Sri Lankan economy are relatively high.

As can be seen in Table 5, sectors with strong downstream linkages include (1) manufacture of products of wood, (2) agriculture & livestock, (3) machinery, (4) financial intermediation services and investment banking, (5) insurance and pension services, (6) mining and quarrying, electricity, gas and water, and (7) forestry: wood & natural rubber. Output of these sectors' are utilized by other sectors as inputs in their production processes. Therefore, the successes of the sectors depend on the supply of inputs from other sectors, which in turn affect the successes of the later. This implies the importance of strengthening industries which have either upstream or downstream linkages or both. As the sector 6 mentioned above has strong downstream linkages to other sectors in the economy, higher prices (or taxes) charged on electricity and water would probably result in higher costs to most other sectors in the economy.

The results presented in Table 5 also show that there are 12 sectors in the economy which are weakly connected to the other sectors of the economy. There include such sectors as education whose output cannot be used as direct inputs for many sectors in the economy. Therefore, based on the linkage measures or multiplier analysis deciding whether a sector is a key one or not should be done very carefully.

CONCLUSION

This paper is aimed at measuring industrial interdependence in Sri Lanka, using a symmetric input-output table for the data 2006 to draw policy relevant lessons to find an effective development strategy for the country. Five key industries of the Sri Lankan economy have been identified from the study in terms of output, value added and income multipliers. These

include: (1) recreational, cultural, sporting services and other services; (2) manufactured products of food, beverages and tobacco sector; (3) air transport services; (4) rubber & plastic products; and (5) metallic, non-metallic and mineral products. The sectors such as 'water transport service', 'education services', 'wood & natural rubber', and 'wholesale and retail' have lower income multipliers, reflecting the fact that their wage shares in total industry output are at lower levels. The employment multipliers are highest in the sectors such as: (1) real estate services; (2) electrical products; (3) petroleum & chemical products; and (4) rubber & plastic products industries. Unlike the ranking of sectors based on the output, value addition and income multipliers, real estate activities become the leading sector of the economy in terms of generation of employment opportunities.

There are five industries (sectors) which have strong upstream and downstream vertical integrations among other sectors in the economy. These sectors are: (1) the recreational, cultural, sporting services and other services; (2) manufacture of rubber & plastic products; (3) hotels and restaurants; (4) manufacture of metallic, non-metallic and mineral products; and (5) petroleum & chemical products respectively. The sectors with strong upstream and downstream linkages with other industries mean that they not only utilize a large amount of domestically produced outputs as inputs in their production processes but also their outputs are used in a greater extent by other sectors in the economy as inputs so as to produce the final goods and services. However, as sector 4 and 5 are using more than one thirds of imported inputs (about 33% and 34% respectively) in their production process, it leads to reduce the domestic impact by these sectors in the Sri Lankan economy. A less dependency on imported inputs is reported from the sectors: 3 (5.1%); 2 (6.2%); and 1(13%). It means that these sectors have relatively higher domestic impacts into the Sri Lankan economy.

Based on the results of average coefficient of variations (not shown here) with regard to backward and forward linkages, it is found that relatively lower variations in three sectors: 5, 3 and 1 respectively. This implies that the stimuli generated by investment in these three sectors are relatively evenly shared amongst all sectors in the economy. A lowest average coefficient of variation is reported from the petroleum & chemical products. Higher prices charged on products such as petrol, diesel etc. in this sector results in higher costs to most of other sectors in the economy.

The sector: 'mining and quarrying, electricity, gas and water', has strong downstream linkages to other sectors in the economy, higher prices (or taxes) charged on electricity and water would probably result in higher costs

to most of other sectors in the economy. These results emphasises the importance of strengthening the industries which have either upstream or downstream linkages or both. When compared the information given in Figure 1 with the results in input-output analysis, it is very clear that industries should be prioritized based on an input-output analysis rather than just depending on the information provided by percentage of contribution in output and value addition to GDP by the sectors. However, the results should be interpreted very carefully as the impact of some sectors such as education difficulty to be practically measured in monetary terms based on an input-output model.

In implication, the study evolves with some limitations. First, IO analysis ignores the supply-side and capacity constraints of the economy. Second, it ignores price changes of both commodities and factors of production. Because of these reasons, results obtained might to be overestimated the "true" impact. Third, it ignores the economies of scale in the production process. Finally, it is based on highly aggregated versions of sectors (30) which could in turn lead to underestimate or overestimate of the real situation of an economy. Nevertheless these limitations, this input-output analysis will be very useful in development planning and sectorial policy designing processes.

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APPLICATION OF CHOICE EXPERIMENT: THEORETICAL ASPECT

RESEARCH ARTICLES
Sri Lanka Journal of Economic Research
Volume 3 (2)
December 2015: 31-54
Sri Lanka Forum of University Economists

SLJER

Wasantha Athukorala
Muditha Karunarathna

Abstract

Among the environmental valuation methods, the Choice Experiment (CE) method is considered to be the most appropriate method for valuing benefits of attributes related to a particular environmental commodity. This is because of the CE method allows not only for estimation of the value of the environmental good as a whole, but also for the implicit values of its attributes. Under this method a sample of people is asked to choose their most preferred alternatives from a sequence of grouped options that relate to different management strategies. Each option is described in terms of its outcomes and a personal monetary cost to be borne personally by the respondent. In analysing the choices made by respondents, it is possible to infer the trade-off that people are willing to make between money and greater benefits of different attributes. This paper aims at explaining the basic steps of undertaking a choice experiment study which is increasingly becoming popular technique in both the developed as well as in developing countries. Researchers who are interested in applying CE method for their research can use this as a basic guidance for their work.

Keywords: *Environmental valuation, Choice Experiment (CE) method, Management strategies, Developing countries.*

Wsantha Athukorala
Senior Lecturer, Department of Economics and Statistics, University of Peradeniya, Sri Lanka. Email: wathukorala@yahoo.com

Muditha Karunarathna
Senior Lecturer, Department of Economics and Statistics, University of Peradeniya, Sri Lanka.

INTRODUCTION

The valuation of nonmarket goods is one of the principle issues addressed by environmental economics research (Champ et al., 2004). When competitive markets exist, market prices are the appropriate measure of social well-beings. However, in practice, all markets do not function exactly in the manner assumed by economic theory. In such cases market prices are not the best available approximate measures of social values of goods and services (Freeman, 2003). There are two main valuation techniques which are widely used in environmental economics. The first method is the revealed preference techniques where people's preferences for particular commodity are revealed through their actions in related markets. The second method is the stated preference techniques that require people to state the strength of their preferences and hence reveal the values they enjoy through structured questionnaires (Bishop and Romano, 1998). This method does not involve any reliance on market data.

For market based valuation techniques, the benefit generated by the environmental commodities must be bought and sold in markets. Hence, the techniques are mostly suitable for application where direct use benefits are involved. As both consumer and producer receive the benefits, consumer surplus and producer surplus can be used to measure the total benefits received from use value of the commodity. Therefore, it is clear that if there are sufficient observations of trade, it is possible to use standard economic techniques to estimate values for both buyers and sellers (Freeman, 2003). For example, if a species is under threat of extinction, the cost of a captive breeding program may be used to estimate the benefit being provided by its continued survival. Another approach involves the estimation of how much it would cost to replace the lost of a forest area with a substitute. This replacement cost technique is widely used in various analyses because of its reliability as well as the simplicity of capturing the relevant cost.

Limitations of the market based or revealed preference techniques, led to the development of stated preference techniques (Champ et al., 2004). In this type of technique, a sample of people are asked about their preferences for a sensitive asset under a hypothetical set of circumstances. A number of different methods have been developed to inquire about peoples' preferences. The first stated preference technique

to be developed was the contingent valuation method (CVM)[1]. Originally, this method required that a sample of people be asked the amount they would be willing to pay to secure an improvement in a particular aspect of the environmental commodity. More recently, this technique has been refined to accommodate a dichotomous choice version that involves people being asked if they would or would not support a proposal to improve the existing system given some personal monetary cost (Karunarathna, 2012). This is the basic idea of choice experiment method. In a CE, individuals are presented with a choice set or series of choice sets that are framed with various attributes and attribute levels and are asked to choose one bundle at a varied set of price and attribute levels. Consumers' willingness to accept (WTA) compensation payment for each attribute is then computed from estimates of econometric models.

Although CE method is the most reliable approach to estimate the non-market benefits, application in developing countries is limited. Given its complexity as well as the requirement of the theoretical and empirical knowledge, most people are reluctant to apply this methodology in their studies. This paper attempts to explain the basic steps of the CE procedure which will enhance theoretical as well as empirical knowledge in this area. Basic methodology has a theoretical grounding in Lancaster's attribute theory of consumer choice (Lancaster, 1966) and an econometric basis in models of random utility (Luce, 1959; McFadden, 1974). Therefore, RUM is explained in the next section.

RANDOM UTILITY MODELS (RUM)

The CE methods rely on the random utility model framework to provide a utility theoretical interpretation of the discrete responses observed from the respondents. Garber-Yonts (2001) provided the basic steps of RUM and a derivation of WTP compensation that is explained below. Given a set of alternatives A_n, presented to an individual n, the probability that any one alternative i is chosen is given by:

$$P(i / A_n) = \Pr(U_{in} \geq U_{jn}, V_j \in A_n) \qquad (1)$$

[1] The idea of CVM was first suggested by Ciriacy-Wantrup (1947), and the first study ever done was in 1961 by Davis (1963).

Where, U_{in} is the utility that individual n achieves by choosing alternative i. According to the random utility theory, the utility which is not directly observable can be partitioned into a deterministic component and a random component (Ben-Akiva and Lerman 1985; Garber-Yonts, 2001). The accompanying assumption is that the individual knows their utility function with certainty, however with other measurement errors, utility can be stochastic:

$$U_{in} = V_{in} + \varepsilon_{in} \quad (2)$$

Where, V_{in} is the mean and the random disturbance of the stochastic random utility function. The specification of V_{in} includes a vector of attribute of alternative i, X_{in}, which includes a price or bid variable, and a vector of characteristics of the respondent, H_n, including income (Garber-Yonts, 2001). Thus model can be written as Equation 3:

$$U_{in} = \beta' f(X_{in}, H_n) + \varepsilon_{in} \quad (3)$$

Where, the deterministic component is here specified as linear in parameters, though the function *f(.)* can be nonlinear. However, when choosing the functional form, there is a trade-off between the benefits of assuming a less restrictive formulation and the complications that arise from doing so. This is especially relevant for the way income enters the utility function (Garber-Yonts, 2001). A simpler functional form (e.g. linear in income) makes estimation of the parameters and calculation of welfare effects easier, but the estimates are based on restrictive assumptions (Ben-Akiva and Lerman, 1985). Most often researchers have been inclined to use a simpler linear in the parameters utility function. Another important thing is that the error term enters the utility function as an additive term. This assumption, although restrictive, greatly simplifies the computation of the results and the estimation of welfare measures. With the indirect utility specified as above, the individual seeks to maximize utility such that:

$$P_n(i/A_n) = P(\beta' f(X_{in}, H_n) + \varepsilon_{in} > \beta' f(X_{jn}, H_n) + \varepsilon_{jn}$$

$$P_n(i/A_n) = P(\beta' f(X_{in}, H_n) - \beta' f(X_{jn}, H_n) \geq (\varepsilon_{jn} + \varepsilon_{in})); i, j \in A_n, i \neq j \quad (4)$$

It becomes clear that unless H_n enters the function *f(.)* nonadditively, it appears identically on both sides of the inequality and cancels out of the function. Thus, H_n must enter nonadditively if the effects of respondent characteristics on choice are to be measured (Garber-Yonts, 2001). If ε_{in} and ε_{jn} are assumed to be extreme value independently and identically distributed (IID) with scale parameter μ, then $\varepsilon^{*} = \varepsilon_{jn} - \varepsilon_{in}$ is logistically distributed (Ben-Akiva and Lerman, 1985). This distributional assumption approximates the normal distribution which leads to the multinomial logit (MNL) model for the choice probabilities (McFadden, 1974; Ben-Akiva and Lerman, 1985). This is the simplest version of the analysis of multinomial outcomes when comparing with conditional logit (CL) model and RPL model. MNL model can be given as Equation 5:

$$P_n(i/A_n) = e^{\mu V_{jn}} / \sum_{j \in A_n} e^{\mu V_{jn}} = e^{\mu \beta' f(X_{in}, H_n)} / \sum_{j \in A_n} e^{\mu V_{jn}} = e^{\mu \beta' f(X_{jn}, H_n)} \quad (5)$$

Since μ appears as a multiplicative constant on every parameter of the model, it is not identifiable. A common assumption employed by users of MNL models is that the scale parameter, μ, is equal to one, which has a homoscedastic disturbance (Garber-Yonts, 2001). Empirical observations about this assumption found that it was not significantly different that one (Xu, 1997; Adamowicz et al., 1998). Therefore, we adhere to this assumption in this study. The log likelihood function for the MNL model can be written as Equation 6:

$$\ln L = \sum_n \sum_{i \in A_n} s_{in} P\,(i/A_n) = \sum_n \sum_{i \in A_n} s_{in} [\beta' f(X_{in}, H_n) - \ln \sum_{j \in A_n} \beta' f(X_{jn}, H_n)] \quad (6)$$

Where $s_{in} = 1$ if alternative *i* is chosen by individual *n*, otherwise $s_{in} = 0$. Garber-Yonts (2001) provides the details explanation about the derivatives of all Equations related to MNL. The necessary first order conditions to maximize the likelihood function are obtained by setting the first derivative of Equation 6 with respect to the parameter vector equal to zero:

$$\frac{\partial}{\partial \beta} ln\ L = \sum_n^N \sum_{i \in A_n} s_{in} \left[f(X_{in}, H_n) + \frac{\sum_{j \in A_n} e^{\mu \beta' f(X_{in}, H_n)} (f(X_{in}, H_n))}{\sum_{j \in A_n} e^{\mu \beta' f(X_{in}, H_n)}} \right] = 0 \quad (7)$$

Estimation of the parameters of this model can be done by using maximization of the multinomial likelihood. This usually requires numerical procedures, and Fisher scoring or Newton-Raphson often work rather well. McFadden (1974) argues that, under certain conditions, *ln L* in Equation 6 is globally concave so that a solution to Equation 7 exists and is unique. Thus the maximum likelihood estimator of β is consistent, asymptotically normal, and asymptotically efficient.

Estimation of Hicksian welfare effects from the MNL choice probabilities follows the method outlined by Hanemann (1984) and Hanemann and Kanninen (1999). Given a quantity change in the level of a public good from X^0 to X^1, the compensating surplus which exactly offsets the utility gain of the change is the level of *B* which provides the equality:

$$v(p, X^1, y - B, H, \varepsilon) = v(p, X^0, y, H, \varepsilon) \qquad (8)$$

where *v* is indirect utility, *p* is the vector of market prices, a *X* is vector of attributes other than the bid level *B*, *y* is income, *H* is a vector of the socio-demographic characteristics, and ε is a random error term. The objective is to obtain the solution for the expected value of $B = B(p, X^0, X^1, y, H, \varepsilon)$, which is the maximum WTP for the change from X^0 to X^1. Assuming the additive separability of the cost attribute of the individual's indirect utility function, we can express the deterministic part of utility as shown in Equation 9:

$$v_{in} = \beta' f(X_{in}, H_n) + \alpha B_{in} \qquad (9)$$

Where, *B* is the specified bid level alternative *i*, and α is associate parameter. The following measures Total WTP/Total WTA (TWTP/TWTA) for a change in the attributes of a good from state *i* to state *j* aggregated over all observations (Hanemann, 1984; Adamowicz et al.,1994; Xu, 1997; Garber-Yonts, 2001):

$$TWTP/TWTA = CS = -\frac{1}{\alpha}\left\{ ln \sum_{i \epsilon A} e^{v_{in}} - ln \sum_{j \epsilon A} e^{v_{jn}} \right\}$$

$$= -\frac{1}{\alpha}\left\{ ln \sum_{i \epsilon A} e^{\beta' f(X_{in}, H_n) + \alpha B_{in}} \right\} - \left\{ ln \sum_{j \epsilon A} e^{\beta' f(X_{jn}, H_n) + \alpha B_{jn}} \right\} \quad (10)$$

If the mean value of TWTP/TWTA for the change in all attributes from state *i* to state *j* is for interest, Equation 10 simplifies to:

$$TWTP/TWTA = CS = -\frac{1}{\alpha}[\alpha(B_i - B_j) + \beta'(f(X_i, \overline{H}) - f(X_j, \overline{H})] \quad (11)$$

where *f(X,H)* is evaluated at the sample mean value of *H*, recalling that *H* drops out of the Equation if it enters *f(.)* additively. The TWTP/TWTA for the "part-worth" of the change of an individual attribute *k* from state *i* to state *j*, holding other attributes constant, further simplifies to Equation 12:

$$TWTP/TWTA_k = CS_k = -\frac{\beta_n}{\alpha}[f(X_{ik}, \overline{H}) - f(X_{jk}, \overline{H})] \quad (12)$$

Finally, as adopted by Hanemann et al. (1991); Xu (1997) and Garber-Yonts, (2001) the Hicksian compensated demand curve, depicting marginal WTP/WTA for attribute *k* at level *i*, is given as Equation 13:

$$TWTP/TWTA_k = \frac{\partial}{\partial X} CS = -\frac{\beta}{\alpha} f(X_{ik}, \overline{H}) \quad (13)$$

In choice modelling applications, different components of specific public good as well as monetary factors should be included as attributes of the options in a choice set. Thus, choice modelling allows one to obtain compensating surplus estimates so that one can account for the welfare change generated by a bundle of changes in relevant attributes. It is also possible to determine the relative importance of these attributes to people in making their choices. Haneman and Kanninen (1999) make an important distinction between the conventional regression techniques used in analysis of open ended WTP data and the limited dependent variable models used in conjunction with discrete

choice elicitation methods. With the former, the investigator obtains an estimate of the mean WTP conditional on the regressors. The later estimates the entire conditional cumulative distribution function (cdf) of the dependent variable. The preferred measure of central tendency by which to summarize the estimated cdf is therefore at the discretion of the investigator, and its selection can significantly alter the results of the analysis (Garber-Yonts, 2001).

It is clear now that the choice experiment technique is an application of the characteristics theory of value combined with random utility theory (see, for example, Thurstone, 1927; Lancaster, 1966; Manski, 1977). In this method, respondents are asked to choose between different bundles of (environmental) goods, which are described in terms of their attributes, or characteristics, and the levels that these take. The CE approach is essentially a structured method of data generation. It relies on carefully designed choice tasks that help reveal the factors influencing choice. Designing a CE technique requires careful definition of the attribute levels and ranges. Furthermore, the choice experiment approach involves the use of statistical design theory to construct choice scenarios which can yield parameter estimates that are not confounded by other factors. In the next section, we discuss the main steps that we should follow when applying CE method for environment valuation.

CHOICE EXPERMENT (CE) METHOD

As mentioned in the previous section, the CE method has its theoretical grounding in Lancaster's model of consumer choice (Lancaster, 1966). Lancaster proposed that consumers derive satisfaction not from goods themselves, but from the attributes they provide. To illustrate the basic model behind choice experiments, assume that particular household has a utility function of the form:

$$U_{i\ j} = U(X_{i\ ,j} Z_i) \qquad (14)$$

Where, for any household i, a given level of utility will be associated with any alternative of the commodity j. Utility derived from any alternatives depend on the attributes of the commodity X_{ij} and the social and economic characteristics of the household Z_i, since different household 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):

$$U_{ij} = T_{ij} + e_{ij} \quad (15)$$

The systematic component can be explained as a function of the characteristics of the commodity and of the social and economic characteristics of the household. Accordingly, Equation 15 can be expressed as $U_{ij} = T(X_i, Z_i) + e_i$. Given an error part in the utility function, predictions cannot be made with certainty and the analysis becomes one of probabilistic choice (Bateman et al., 2003). Consequently, choices made between alternative commodities will be a function of the probability that the utility associated with a particular commodity option (j) is higher than that for other alternative commodities. Hence, the probability that household i will choose commodity j over all other options n is given by:

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

We assume that the relationship between utility and attributes follows a linear path in the parameters and variables. We further assume that the error terms are identically and independently distributed with a Weibull distribution[2] (Greene, 1997). These assumptions ensure that the probability of any particular alternative *j* being chosen can be 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:

$$P_{ij} = \frac{\exp(X_i'\beta + Z_i'\alpha)}{\sum_{j=1}^{J} \exp(X_i'\beta + Z_i'\alpha)} \quad (16)$$

[2] Weibull distribution is a continuous probability distribution. For further details about the basic properties of this distribution, please see Greene (1997).

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 choices. Equation 16 is the probabilistic response function and it shows that, given all other options the probability that household *i* selecting the option *j* type commodity. The CL model generates results for a conditional indirect utility function of the form:

$$T_{ij} = \beta + \beta_1 X_1 + \beta_2 X_2 + ...+ \beta_m X_m + \alpha_1 Z_1 + \alpha_2 Z_2 + ...+ \alpha_k Z_k \quad (17)$$

where β is the alternative specific constant (ASC), that captures the effects in utility from any attributes not included in choice specific attributes (Rolfe et al., 2000). The number of attributes of the commodity considered is *m* and the number of social and economic characteristics of the household to explain the choice of the commodity 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 (Bateman et al., 2003). When parameter estimates are obtained, welfare measures can be estimated from the CL model using the following formula:

$$CS = \frac{\ln \sum_i \exp(T_{i1}) - \ln \sum_i \exp(T_{i0})}{\delta} \quad (18)$$

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 18 to 19:

$$W = -\left(\frac{\beta_{attribute}}{\beta_{monetary\ variable}} \right) \quad (19)$$

Equation 19, the implicit prices *(W)* for the various 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 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. It also provides a flexible and computationally practical econometric method for any discrete choice model derived from random utility maximisation (McFadden and Train, 2000). 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). Furthermore, accounting for heterogeneity enables prescription of policies that take equity concerns into account. This is because an understanding of who will be affected by a policy change in addition to understanding the aggregate economic value associated with such changes is necessary (Boxall and Adamowicz, 2002). Formally, the random utility function in the RPL model is given by:

$$U_{ij} = U[X_j(\beta + \mu_i), Z_i)] \tag{20}$$

Similarly, to the CL model, indirect utility is assumed to be a function of the choice attributes (X_j), with parameters β, which due to preference heterogeneity may vary across respondents by a random component μ, and of the social, economic and attitudinal characteristics (Z_i), namely income, education, household size and attitudes towards the relevant good or service. By accounting for unobserved heterogeneity, Equation 16 now becomes:

$$P_{ij} = \frac{\exp[X_{ij}^{'}(\beta + \mu_i) + Z_i^{'}\alpha]}{\sum_{j=1}^{J} \exp[X_{ij}^{'}(\beta + \mu_i) + Z_i^{'}\alpha]} \tag{21}$$

Since this model is not restricted by the IIA assumption, the stochastic part of utility may be correlated among alternatives and across the sequence of choices via the common influence of μ_i. Treating preference parameters as random variables requires estimation by simulated maximum likelihood (Kikulwe et al., 2011). In general, the maximum likelihood algorithm searches for a solution by simulating *n* draws from distributions with given means and standard deviations. Probabilities are calculated by integrating the joint simulated

distribution. Recent applications of the RPL model have shown that this model is superior to the CL model in terms of overall fit and welfare estimates (Breffle and Morey, 2000; Layton and Brown, 2000; Carlsson et al., 2003; Kontoleon, 2003; Lusk et al., 2003; Morey and Rossmann, 2003).

Even if unobserved heterogeneity can be accounted for in the RPL model, the model fails to explain the sources of heterogeneity (Boxall and Adamowicz, 2002). This can be done by including interactions of respondent-specific social, economic and attitudinal characteristics with choice specific attributes and/or with ASC in the utility function. This enables the RPL model to pick up preference variation in terms of both unconditional taste heterogeneity (random heterogeneity) and individual characteristics (conditional heterogeneity), and hence improve model fit (e.g. Revelt and Train, 1998; Morey and Rossmann, 2003; Kontoleon, 2003). In the context of empirical application of choice experiment model, choice experiment design as well as model selection steps are extremely important. Therefore, the next section discusses basic steps of choice experiment design and selecting the appropriate model for econometric estimation.

CHOICE EXPERIMENT DESIGN AND MODEL SELECTION

In the CE method[3], respondents are presented with panels of choices with two or more alternatives each, where each alternative is a bundle of attributes which are specified at different levels in each alternative (Louviere et al., 2000). The inclusion of a price or cost attributes permits estimating the effect of cost on the respondents' choice. For example, if we consider farmers' preference for different type of farms, a farmer may choose from a number of different farms in her choice set, each of which exhibits variation in an array of attributes such as crops diversity, livestock diversity, mix farming system, landrace cultivation and organic production. A farmer chooses the type of farm in a given season depending on the balance of preferences for different attributes and the degree to which they are represented at a given farm. In a survey context, the researcher should identify the essential attributes and levels of the environmental goods in question and designs the

[3] For a detailed explanation of choice experiment design techniques, please see Louviere et al. (2000),
Bennet and Blamey (2001) and Bateman et al. (2002)

choice question to reveal the structure of the respondents' preferences (Bateman et al., 2002).

Adamowicz et al. (1999) provided several stages of designing a CE study. They are as follows:

1. Identification of relevant attributes
2. Selection of measurement unit for each attribute
3. Specification of the number and magnitude of the attribute levels
4. Experimental design
5. Model estimation
6. Use of parameters to simulate choice

The first three steps are involved in developing a concise and sufficiently complete representation of the valuation scenario which will provide the survey respondent with appropriate information set on which to base statements of preference. This phase uses information obtained from secondary sources, experts in the field, focus groups and personal interviews in order to refine the informational content of the survey instrument. The selection of attributes in relation to the choices of interest is very important in framing a CE exercise. According to Blamey et al. (2000) attribute selection needs to take place from both the perspectives of the end-user (the population of interest) and the decision-makers/resource managers to ensure that the attributes are not only easily identifiable, but produce policy-relevant information. Another goal of the attribute selection process is to minimize the number of attributes as the use of a large number of attributes is likely to lead to lower data reliability due to the excessive cognitive burden it would place on respondents (Mogas et al., 2002). Identification of appropriate attribute ranges is another basic framing task in choice experiment, as a failure to accept trade-offs indicates that the range of attribute levels offered is not salient (Johnson et al., 2000). In determining how many attributes to include in a study design, there is often a trade-off between describing trade-offs accurately (requiring more attributes) and minimizing choice and experimental design complexity (requiring fewer attributes). Louviere and et al. (1993) claims to have successfully administered surveys with up to 32 choice tasks though this requires scaling down the number of alternatives and attribute levels accordingly. Boxall et al. (2002) suggests that respondents can endure large numbers of choice sets but sets with more than six alternatives tend to exceed cognitive limits. Louviere et al. (1993) suggest that the average choice experiment survey employs

seven attributes, four choice sets and four alternatives per set, though they note that there is a great deal of variability and this average does not constitute a best practice.

After identifying the attributes for a particular experiment, the analyst must assign values or levels to each attribute. These levels should be chosen to represent the relevant range of variation in the present or future interest of respondents. In general, focus group discussions will indicate the level of the attributes as well as the best way to present them. Though commonly presented in words and numbers, attribute levels may be presented using pictures. To the extent that visual representations of attribute levels are utilised, it is likely that respondents will perceive levels more homogeneously, likely leading to more precise parameter estimates in the modelling stage (Alpizar et al., 2001).

Experimental design[4] is the next important aspect of choice modelling and it is concerned with how to create the choice sets in an efficient way or how to combine attribute levels into profiles of alternatives and profiles into choice sets. In practice, a design is developed in two steps: (i) obtaining the optimal combinations of attributes and attribute levels to be included in the experiment and (ii) combining those profiles into choice sets. A starting point is a full factorial design, which is a design that contains all possible combinations of the attribute levels that characterize the different alternatives. A full factorial design is, in general, very large and not tractable in a choice experiment (Louviere et al., 2000). Therefore, we need to choose a subset of all possible combinations, while following some criteria for optimality and then construct the choice sets. The standard approach used in most research has been to use orthogonal designs, where the variations of the attributes of the alternatives are uncorrelated in all choice sets. More recently researchers in marketing have developed design techniques based on the Doptimal criteria for non-linear models in a choice experiment context. However, there can be some problems with these more advanced design strategies due to their complexity, and it is not clear whether the advantages of being more statistically efficient outweigh the problems (Scarpa and Rose, 2008)[5].

[4] This step is much more complex in choice experiment in that the experimental design is critical to producing a data set that will yield estimable parameters for the attributes in an econometric model of preferences.

[5] For example, utility balance in more advanced design makes the choice harder for the respondents, since they have to choose from alternatives that are very close in terms of utility.

As mentioned above, the most well-known fractional factorial design type is the orthogonal design, which aims to minimise the correlation between the attribute levels in the choice situations (Kuhfeld, 2005). However, these orthogonal designs have limitations and cannot avoid choice situations in which a certain alternative is clearly more preferred over the others (hence not providing much information). More recently, several researchers have suggested another type of fractional factorial designs, so-called efficient designs (Hensher et al., 2005; Scarpa and Rose, 2008). Instead of merely looking at the correlation between the attribute levels, efficient designs aim to find designs that are statistically as efficient as possible in terms of predicted standard errors of the parameter estimates. Essentially, these designs attempt to maximise the information from each choice situation. In case any information about the parameters is available, then efficient designs will always outperform orthogonal designs (Kessels et al., 2006). This is due to the fact that efficient designs use the knowledge of the prior parameters to optimise the design in which the most information is gained from each choice situation (e.g. dominant alternatives can be avoided as the utilities can be computed). While efficient designs outperform the orthogonal designs, prior parameter estimates need to be available (Hensher et al., 2005). Therefore, efficient designs rely on the accuracy of the prior parameter estimates.

Three reasons can be given to justify using orthogonal design in a particular study. Firstly, it allows for an independent estimation of the influence of each design attribute on choice. Secondly, with the absence of prior parameter, there is no way to apply efficient design in the study. Thirdly, the common use of orthogonal designs in stated choice studies is largely a result of historical impetus. In the past, the experimental design literature has been primarily concerned with linear models (such as linear regression models), where the orthogonality of data is considered important (Scarpa and Rose, 2008). In linear regression models, this is because (a) orthogonality ensures that the model will not suffer from multicolinearity, and (b) orthogonality is thought to minimise the variances of the parameter estimates, which are taken from the variance-covariance (*VC*) matrix of the model (Hensher et al., 2005). The *VC* matrix of a linear regression model is given in Equation 22.

$$VC = \sigma^2 \left[X' X \right]^{-1} \tag{22}$$

where σ^2 is the model variance, and *X* is the matrix of attribute levels in the design or in the data use to estimate. Fixing the model variance,

the elements of the *VC* matrix for linear regression models are minimised when the *X* matrix is orthogonal. A design that results in a model where the elements contained within the *VC* matrix are minimised is preferable, for two reasons (Hensher et al., 2005). Firstly, such a design will produce the smallest possible standard errors, and hence maximise the *t*-ratios produced from that model. Secondly, an orthogonal design will produce zero-off diagonals in the models *VC* matrix, thus ensuring that the parameter estimates are unconfounded with one another (or no multicollinearity problem). As such, orthogonal designs, at least in relation to linear models, meet the two criteria for a good design (Scarpa and Rose, 2008). They allow for an independent determination of each attributes contribution on the dependent variable, and they maximise the power of the design to detect statistically significant relationships (e.g. maximise the *t*-ratios at any given sample size).

The next step of choice experiment involves econometric model selection and estimation. The most common model estimated in economics literature has been the MNL model, and the most common estimation criterion is maximum likelihood. The MNL model is easy to estimate, and interpretation is straightforward. However, there are also examples of other choice model specifications such as CL model and RPL model. Selection between MNL and CL depends on whether the researcher is interested in including socioeconomics variables in addition to the choice attribute into the model. If researcher uses only choice attributes, MNL model can give higher accuracy of the model fits. However, if the researcher uses choice attributes as well as socioeconomic variables into the model, CL model provides more accurate results (Rolfe et al., 2000). In empirical setting, inclusion of social and economic characteristics is also beneficial in avoiding IIA violations, since social and economic characteristics relevant to preferences of the respondents can increase the systematic component of utility while decreasing the random error (Rolfe et al., 2000; Bateman et al., 2003).

The MNL model relies on the assumption of the independence of irrelevant alternatives[6]. The IIA arises from the assumption about the IID of the error term. IID of error term means that it has an extreme value error distribution. The IIA means that the probability of choosing

[6] The independence of irrelevant alternatives means that, all else being equal, a person's choice between two alternative outcomes is unaffected by what other choices are available.

an alternative is dependent only on the options from which a choice is made, and not on any other options that may exist. If the IIA/IID is violated, the estimates derived from the model could be biased and not generate accurate values for inclusion in cost benefit analysis (Ben-Akiva and Lerman, 1985). The IIA property allows the addition or removal of an alternative from the choice set without affecting the structure or parameters of the model. This assumption has three main advantages. Firstly, the model can be estimated and applied in cases where different members of the population face different sets of alternatives. Secondly, this property simplifies the estimation of the parameters in the MNL and CL models. Third, this property is advantageous when applying a model to the prediction of choice probabilities for a new alternative. On the other hand, the IIA property may not properly reflect the behavioural relationships among groups of alternatives (Hensher et al., 2005). That is, other alternatives may not be irrelevant to the ratio of probabilities between a pair of alternatives. In some cases, this will result in erroneous predictions of choice probabilities.

There are various reasons why IIA/IID violation could occur. One possibility is the existence of random taste variations (that is heterogeneity). To account for this, a model which includes socioeconomic variables in addition to the attributes in the choice sets can be estimated (Bennett and Blamey, 2001). The socio-economic information could be included in two different ways. The first is by interactions with the attributes in the choice sets. The second method includes the socio-economic information through interactions with the alternative specific constants. These interactions show the effect of various socio-economic characteristics on the probability that a respondent will choose particular options.

Alternative model specifications to MNL models are CL and RPL. The CL model allows us to estimate the effect of choice-specific variables on the probability of choosing a particular alternative. The CL model also assumes the IIA property, which states that the relative probabilities of two options being chosen are unaffected by introduction or removal of other alternatives. In other words, the probability of a particular alternative being chosen is independent of other alternatives. If the IIA property is violated then CL model results will be biased and hence a discrete choice model that does not require the IIA property, such as the RPL model, should be used. To test whether the CL model is appropriate, the Hausman and McFadden (1984) test for the IIA property can be employed. In this case, whether or not IIA property

holds can be tested by dropping an alternative from the choice set and comparing parameter vectors for significant differences. A RPL model is a generalization of a standard multinomial logit. The advantages of a RPL model are that (i) the alternatives are not independent (the model does not exhibit the independence of irrelevant alternatives property) and (ii) there is an explicit account for unobserved heterogeneity.

CHOICE EXPERIMENT SURVEY

Under the CE method a sample of people is asked to choose their most preferred alternatives from a sequence of grouped options that relate to different management strategies. Each option is described in terms of its outcomes and a personal monetary cost to be borne personally by the respondent. In general, survey is the common technique that is used to collect data. The questionnaire is usually a paper and pencil task that is presented through an interviewer. While its main content will be different choice scenarios through which the respondent will be guided, it may also include sections requesting socio-demographic, economics, and attitudinal and past behaviour data[7].

In general, the questionnaire needs to be developed using the results from focus groups' discussions and a pre-test. The purposes of the focus group studies are to determine attributes relevant to respondents and policy makers and test a draft questionnaire. Also before the interview starts it is required to confirm whether the respondents are generally those responsible for decision making. In face-to-face interviews, each respondent can be presented with several choice sets showing various options. Before answering the choice sets, respondents need to be requested to keep in mind their available income, food consumption expenditure, available labour, size of the land and other things on which they may consider when making a decision. It is obvious that the CE part is the most important section of the questionnaire and it needs expert knowledge and careful attention. In a CE, individuals are presented with a choice set or series of choice sets that are framed with various attributes and attribute levels and are asked to choose one bundle at a varied set of price and attribute levels. Consumers' willingness to accept (WTA) compensation payment for each attribute is then computed from estimates of econometric models. An intrinsic

[7] Socio economic aspects such as community, gender, age, marital status, literacy level, income, expenditure, savings and indebtedness provide a base for studying the impact of any program.

problem that all researchers face in designing a survey questionnaire is how much information or complexity to incorporate. Specifically, these issues may include which attributes should be used, how many levels of each attribute need to be considered, how many alternatives need to be presented in each choice set, and how many choice sets should be included in each questionnaire. The process for designing CE questions must be able to answer all these questions carefully.

CONCLUSION

The overall objective of this paper is to explain the basic steps of the CE method. CE study estimates the possible benefits that could be achieved from changing existing scenario to a new scenario. Under this method a sample of people is asked to choose their most preferred alternatives from a sequence of grouped options that relate to different management strategies. Each option is described in terms of its different outcomes and a monetary cost to be borne personally by the respondent. By analysing the choices made by respondents it is possible to infer the trade-offs that people are willing to make between money and greater benefits of changing the existing situation. A choice experiment is a highly structured method of data generation, relying on carefully designed tasks (experiment) to reveal the factors that influence choices. Experimental design theory is used to construct profiles of the environmental good in terms of its attributes and levels of these attributes. Profiles are assembled in choice sets, which are in turn presented to the respondents, who are asked to state their preferences. In a well-designed CE study, we need to follow all these steps explained in this article in order to increase the accuracy as well as reliability of the results of the study. We need to carefully design the choice experiment survey and used appropriate econometric techniques for the analysis.

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THEORETICAL COMPLIANCE OF MONEY DEMAND FUNCTION OF SRI LANKA

RESEARCH ARTICLES
Sri Lanka Journal of Economic Research
Volume 3 (2)
December 2015: 55-69
Sri Lanka Forum of University Economists

SLJER

***Nanadasiri Keembiyahetti*[1]**
***H.K. Sarath*[2]**
***Chandika Gunasinghe*[3]**

Abstract

This paper derives the monetarist version of broad money demand function for Sri Lankan economy using the quarterly data for the period from 1988: Q1 to 2012: Q4. This study employs both Johansen and Juselius (1990) multivariate method and Granger's (1987) two-step method for co-integration to obtain structural values of the long-run money demand function: The stability of the model is tested using recursive coefficients and cumulative sum of squared residuals (CUSUM) tests. Results obtained from both co-integration testes suggest that the income elasticity of broad money demand is equal to one. Hence, it would provide an important guidance for the monetary authorities to regulate money supply as the intermediate target in order to achieve the final goal/goals of economic and price stability via the monetary transmission mechanism. This study concludes that growth of money over and above the real GDP growth will result inflation. The structural estimate received for inflation is higher than that of the real Treasury bill rate. Both the estimates are in theoretically expected signs and are also statistically significant. It means that public in Sri Lanka tend to substitute money for more real assets than the alternative financial assets during the time of higher inflation. Our tests on the stability of the broad money demand function confirmed that it is stable over time.

Key Words: *Co-integration, Broad money, Money demand function, Quantity theory of money, Stability test, Sri Lanka*

Nanadasiri Keembiyahetti[1]
Senior Lecturer, Department of Economics, University of Ruhuna, Matara, Sri Lanka. Email: nandasiri2007@gmail.com
H.K. Sarath[2]
Senior Lecturer, Department of Economics, University of Ruhuna, Matara, Sri Lanka. Email: katuku@econ.ruh.ac.lk
Chandika Gunasinghe[3]
Senior Lecturer, Department of Economics, University of Ruhuna, Matara, Sri Lanka. Email: chgunasinghe@gmail.com

INTRODUCTION

In practice, clear understanding about the characteristics of the money market, including the money demand function is essential for effectiveness of monetary policy in a country. An optimal monetary policy is hard to be formulated without identifying stable estimates of money demand relation, and other relationships connected to money demand. In Sri Lanka, the monetary policy framework, unfortunately, has not been focused on collecting information on the money demand function. For example, monetary decision very often seems to have manipulated for budgetary support i.e. keeping low Treasury bill rate in order to obtain low cost funds for budgetary needs.

The income and interest rate elasticities of money demand are predominant in most the basic macroeconomic models such as the IS-LM model where the effectiveness of monetary policy depends on the elasticity of money demand. A stable money demand function is a prerequisite to conduct an effective monetary policy in an economy where the monetary aggregate is the target variable. It helps the policy makers to identify the proper and efficient policy instruments to achieve the final economic goals through appropriate intermediate targets.

Further, a stable money demand function helps the policy makers to understand the behaviour of the monetary transmission mechanism, through which the monetary influences are transmitted to the other sectors of the economy, particularly to both financial and commodity markets. Furthermore, the structural coefficients of the demand for money function also provide important policy guidelines to the policy makers. For example, in the quantity theory of money (QTM), income elasticity of money is predicted to be unity, given the constant velocity which is a key assumption of the monetarist view. QTM suggests that the excess money supply can operate the expenditure mechanism enabling economy to increase real output. However, it should be emphasized that although the income elasticity equals unity, it is not a necessary condition for the velocity to be constant over time. The objectives of this study are three folds:

1. To investigate monetarist version of unitary income elasticity of money demand
2. To examine into the stability of Sri Lankan money demand function.
3. To assess the consistency velocity of money in Sri Lanka

In order to achieve those objectives, this study concentrates on the following three issues.

(i). Is the income elasticity of money demand unitary in terms of broad money (m_2) demand relationship?

(ii). Is the inverse velocity constant over time in relation to broad money?

(iii). Is the broad money demand function stable over time?

It is noteworthy that the Sri Lanka's monetary authority has currently focused on the interest rate channel than the channel that suggested in the Quantity Theory Mechanism. The researchers are of the view that it needs be done only after a careful investigation into the Monetary Transmission Mechanism (MTM) through an insightful comparison between alternative channels since another viable channels such as the credit availability mechanism are working in the economy. It means that the monetary authorities have to investigate which monetary influences (i.e. change in money supply or any action to change interest rate) are quickly transmitting into the final goals of monetary policy (i.e. higher economic growth or lower inflation). In this context, this paper attempts to investigate the MTM in terms of the QTM channel by testing whether income elasticity of demand for money is unitary for both narrow and broad money supply.

A BRIEF LITERATURE REVIEW

Derivations of money demand functions are extensively explored in empirical researches however the studies so far done in the Sri Lankan context are limited in number. Haroon, *et all* (2013) examined the stability of money demand function in Pakistan for 1972-2007. The study found that broad money (M2) was the proper aggregate, which provided stable money demand function for Pakistan. The real GDP was positively related to the demand for real balances, while the opportunity cost of money was negatively related. The study found that the role of financial innovation, in explaining the demand for money warrants attention in formulating monetary policy.

Among the studies done in Sri Lankan context, Dheerasinghe (1990) used error correction approach (Engle - Granger (1987) two step method) to the money demand modelling in Sri Lanka based on quarterly data from 1971-1985. Other studies related to money demand functions in Sri Lanka have been limited to identify the factors that determine money demand. These studies include Jayatissa (1984)**,** Ranaweera (1971) Weliwita and Ekanayake (1998), and Wijewardena (1985). However, these papers do not discuss on the important issues that are directly related to the monetarist arguments. Weliwita and Ekanayake (1998) investigated the long-run demand for money and short-run dynamics of the money demand function for Sri Lanka during

the post-1977 period. The study found that M1 is co-integrated with real income, nominal interest rate, short-term foreign interest rate, and real effective exchange rate, whereas M2 was not. This led to the conclusion that monetary authorities should emphasize the narrow definition of money for monetary control. Although the inflation rate is not co-integrated with M1, it seems to be an important determinant of the demand for M1 in the short-run. Results also suggest that the short-term foreign interest rate and the exchange rate can have important implications for the effectiveness of domestic monetary policy.

Mallikahewa and De Silva (2013) empirically investigated the transaction (income elasticity) and speculative motives (interest rate elasticity) of the demand for money in the Sri Lanka employing a co-integration test to the annual data over the 1977 to 2009. The study revealed that money demand function is stable in Sri Lanka for the sample period and the income is the most significant factor influencing the demand for money. Transaction money demand is greater than the speculative money demand in Sri Lankan context.

Dharmaratne (2009) estimated a long run money demand function using quarterly data from 1978-2003 whilst the short run dynamics of the long run money demand has been investigated using an error correction model. The findings of his research revealed that the narrow money demand (M1) is co-integrated with the real income and the nominal interest rate whereas the broad money demand (M2) is not co-integrated with any of the above independent variables. Therefore, author recommends to use narrow money rather than the broad money supply which is not co-integrated with any variables in monetary policy formulation in the country. The study, further found that the one-year term-deposit rate of commercial banks was the best fit for the model used when compared to alternative interest rates such as the 3-month Treasury bill rate, the 12- month Treasury bill rate and the repo rate, implying that the 1-year term deposit rate is the opportunity cost of holding money. Gunasinghe (2006) identified two long run relationships in both narrow and broad money demand models based on multivariate co-integration approach using annual data from 1970 to 2004. First relationship was the long run money demand nexus while next was the inflation output-gap relationship. Furthermore, the author has investigated the applicability of unitary income elasticity in the Sri Lankan context using both money demand models. He found that unitary income elasticity hypothesis is valid only in broad money demand but not in the case of narrow money demand. This may be as a result of presence of rapid technological developments in the narrow money market. The present study differs from the study done by Gunasinghe (2006) in three aspects; first, instead of annual data the present study uses quarterly data from 1988:Q1 to 2012:Q4 which are more appropriate; secondly, the present study concerns

only one co-integration relationship in the broad money demand; and finally, the present study estimates four models pertaining to the broad money demand using both Johansen and Juselius (1990) multivariate method and Engle and Granger (1987) two-step method for co-integration.

A number of studies related to the estimation of money demand functions using multivariate co-integration technique and Engle and Granger (1987) two-step method for co-integration are available in global context too. All these studies more or less concerned only in investigating some common issues in the field such as identifying determinants of money demand and stability of the demand function etc. In contrast this paper works on testing some theoretical prepositions which were first introduced by monetarists on the demand for money function.

METHODOLOGY

In this study, the demand for money refers to the aggregate demand by the public for broad money (M_2). Here the term public is broadly defined as all the economic agents other than the Central Government, the Central Bank and the commercial banks.

Milton Friedman (--) has identified and included three major determinants in his money demand function. (Froyen, 1986). These include total wealth (Wt), expected alternative rate of return on money (R_{bt}), and expected rate of return on other assets (inf^e).

Hence, $\mathbf{m_{2t} = f\ (Wt, R_{bt}, inf^e)}$

Since the wealth and income seem to be co-integrated with each other, both can be represented by the income variable (y) in the demand for money function. It is also worthy to note that if the rate of return on non-money financial assets (Yields on Treasury bills, bonds ...etc.) are co-integrated with one another, these two variables also can be integrated into one variable in the money demand function. The study uses 91 days Treasury bill rate being the representative interest rate for alternative rate of return on money (R_{bt}). In the case of the expected rate of return on other assets it is very important to introduce expected inflation (inf^e) that captures the expected changes of price of goods. Simultaneously it represents the expected rate of return on real assets. In developing countries like Sri Lanka, it can be seen that people more likely to substitute between money and real physical assets rather than money and financial assets e.i investing in housing, and land, purchasing durable consumer and capital goods... etc. Due to the underdevelopment nature of the

financial market (both the money and capital markets) and non-market determined interest rate (regulated interest rate) exist, physical assets may represent one of the major hedges against inflation (Nachega, 2001). Hence a higher degree of inflation elasticity can be generally expected in Sri Lankan context as the range of financial instruments other than money are somewhat limited and the real assets represent a substantial part of the individual investment portfolios.

Accordingly, the broad money demand can be specified as follows;

$$m_{2t} = \beta_1 y_t + \beta_2 inf^e + \beta_3 R91TBt + \varepsilon_t \quad \text{.....(1)}$$

Here all the variables are in real terms except inflation. Income and money supply are in natural logarithms except the three-month real Treasury bill rate ***(R91TB$_t$).*** The unobservable expected inflation, ***inf^e,*** is replaced by an observable ***inf$_t$*** since $et = inf - inf^e$, $et \sim I(0)$. Hence the final set of equations takes the following form;

$$m_{2t} = \beta_1 yt + \beta_2 inf_t + \beta_3 R91TB_t + u_t \quad \text{.....(2)}$$

where,

$$u_t = \varepsilon_t - \beta_2 e_t \sim IDD\ (0, \Omega)$$

Based on equation 2, four extended models can be developed as follows.

$$m_{2t} = \beta_1 yt + u_t \quad \text{..... (Model -1)}$$
$$m_{2t} = \beta_1 yt + \beta_3 R91TB_t + u_t \quad \text{..... (Model -2)}$$
$$m_{2t} = \beta_1 yt + \beta_2 inf_t + \beta_0 + u_t \quad \text{..... (Model -3)}$$

A time variable, t, is included in the fourth model to capture the growth of input and technological progress in the financial market (Hendry and Mizon 1993) as follows.

$$m_{2t} = \beta_1 yt + \beta_2 inf_t + \beta_3 R91TB_t + \beta t + u_t \quad \text{.....(Model-4)}$$

Finally, all four models developed above are estimated based on following test equation;

$$\Delta X_t = \Pi X_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \mu + \varepsilon_t \quad \text{..... .... (3)}$$

where,

$X_t = (m_{2t}, yt, inf, R91TB_t, t)'$ *and t runs from 1 to T.* μ *is a 4 x 1* matrix of unknown

Coefficients. $\Gamma_i = -\sum_{j=i+1}^{p-1} \phi_j$ for $i = 1, 2, p-1$ (ϕ denotes parameters of VAR model comprising 4 × 4 matrices). $\varepsilon_t \sim (0, \Sigma)$ *and* $\Pi = \alpha\beta^{/}$ is a 4× 4 matrix whose rank determines the number of co-integration vectors among four variables in vector, X_t. α *and* $\beta^{/}$ are 4 × r and r × 4 matrices respectively. *r* is the number of co-integration vectors to be determined by Max and Trace testes.

THE SAMPLE AND DATA

The sample period of the study ranges from 1998: Q1 to 2012:Q4. Quarterly data were derived from annual observations for relevant variables using the method proposed by Goldstein and Khan (1976). GDP deflator (1996=100) was used as the general price index to convert nominal variables into real variables and to measure the rate of inflation of the economy. Following are the variables used in the study:

LRM2t = Logged values of real broad money supply (M2) defined as the sum of cash held by public, demand, times and savings deposits held by public at commercial banks.

LRGDPt = Logged values of real gross domestic product (or logged of real income)

R91DTBt = 91 day real treasury bill rate (alternative rate of return of money)

LINFt = inflation rate $(\ln(GDP\ def._t / GDP\ def._{t-1})$

Time series properties of data: Augmented Dickey Fuller (ADF) test

$$\Delta y_t = \mu_0 + \gamma y_{t-1} + \sum_{i=1}^{p-1} \beta_i \Delta y_{t-i} + \beta t + \varepsilon_t$$

$H0: \gamma = 0$ (*the series underconsideration has a unit root*)

$Ha: \gamma < 0$ (*the series underconsideration does not have a unit root*)

RESULTS AND DISCUSSION

If the calculated ADF value is less than the ADF critical value in absolute terms at 5% significant level in general, the null hypothesis (Ho) is not rejected and the series concerned does have a unit root or vice versa. Hence, such a series is said to be integrated of order one I (1) and it qualifies to a possible test of co- integration with a set of variables which have the same time series properties.

Table 1: Augmented Dickey Fuller Test for Unit Roots.

Variables in level form	D.W Value	ADF Test statistic	Critical and Probability values				Nature of integration
			01%	05%	10%	Pro.	
LRM2t	2.11	-2.44	-4.05	-3.45	-3.15	0.357	I (1)
LRGDPt	1.89	-1.88	-4.05	-3.45	-3.15	0.656	I (1)
R91DTBt	1.65	-3.31	-4.05	-3.46	-3.16	0.072	I (1)
LINFt	2.09	-2.69	-3.50	-2.89	-2.58	0.081	I (1)
	Variables in differenced form						
DLRM2t	2.04	-3.50	-3.50	-2.89	-2.58	0.012	I (0)
DLRGDPt	1.90	-4.43	-4.50	-2.89	-2.58	0.000	I (0)
DR91DTBt	1.67	-3.37	-3.50	-2.89	-2.58	0.015	I (0)
DINFt	2.09	-2.69	-3.50	-2.89	-2.58	0.081	I (0)

Source: Authors' calculation using Eviews version 5

The results in Table 1 confirm that all the variables in the study are I (1) in levels and I (0) in their first difference. It implies that all the variables in the study are integrated of order one meaning that each variable has a unit root at levels. This is further confirmed by rejecting the null hypothesis that the first differenced value of each variable has a unit root, meaning that they are integrated of order zero at the first difference. Hence, these variables qualify to be used in testing for a co-integration relationship(s) using either Johansen and Juselius (1990) or Engle and Granger (1987) method.

Table 2: Co-integration Results for Real Broad Money Demand (LRM_2) for Model 4

$\lambda_{trace} = LR(H_r / H_p) = -T\sum_{i=r+1}^{p}\ln(1-\lambda_i)$					$\lambda_{\max} = LR(H_r / H_{r+1}) = -T\ln(1-\lambda_{r+1})$				
Ho:	Ha:	Statistic	Critical and Probability values		Ho:	Ha:	Statistic		Critical and Probability values
r^1		λ_{trace}	0.05	Pro.	r^1		$\lambda_{\max}$	0.05	Pro.
r = 0	r>=1	82.098	63.876	0.0007	r = 0	r =1	38.078	32.118	0.0083
r<=1	r>=2	44.020	42.915	0.0386	r<=1	r = 2	20.951	25.823	0.1932
r<=2	r>=3	23.070	25.872	0.1074	r<=2	r =3	14.167	19.387	0.2431
r<=3	r>=4	8.903	12.518	0.1864	r<=3	r= 4	8.903	12.518	0.1864

Source: Authors' calculations based on Eviews version 5,
Note: r^1= number of co-integration vectors

Table 2 represents only the results of Johansen's co-integration test related to model 4. Data in Table 2 shows that the null hypothesis of no co-integration is rejected at 5% significant level under max and trace statistics for the broad money demand. However, the null hypothesis of the existence of one co-integration relationship is not rejected at 5% significant level under max test whereas it is rejected at the same significant level under trace test (likelihood ratio test). This means that the broad money demand model exhibits a one long run relationship under max test while it shows two long run relationships under trace test. This result is similar to findings in Gunasinghe (2006) where he derived two long run relationships in broad money demand model. However, our main concern is to derive only one relationship and to test the validity of monetarists' prepositions related to broad money demand. Regarding other three models, both max and trace tests (not shown here) of Johansen's co-integration test confirmed a long run relationship in each models. However, these results are entirely contrast to the findings in Dharmarane's (2009) study where he found that the broad money demand (M2) is not cointegrated with any of the selected independent variables such as real income and interest rate.

Table 3: Estimation Results Obtained Using Johansen's Multivariate Method

Dependent variable: Logged of real broad money (LRM2t)				
Independent Variables	Model-1	Model -2	Model-3	Model-4
LRGDP	1.02 (36.00)	0.97 (32.00)	1.00 (52.36)	0.86 (4.56)
LINF	-	-	-0.07 (-5.57)	-0.061 (7.15)
R91TB	-	-0.017 (-1.16)	-	-0.027 (3.29)
Constant	-	-	-1.10 (-4.55)	-
Trend	-	-	-	0.0016 (0.6)
Method: Johansen and Juselius (1990) multivariate co-integration technique t-values are given in parenthesis				

Source: Authors estimates based on Eviews version 5

The estimated results obtained using both Johansen's and Granger's methods for four models specified in section 2 are given in Table 3 and 4. The results of model 1, 2 and 3 given in Table 3 (first three columns) show that the estimates attached to the real income variable in the money demand function are not only exactly equal to one but also they are highly significant with the expected signs. The same estimate in model 4 is also converging to one with a very high t-value, meaning that real income is extremely a significant determinant in the money demand function. It implies that when the real GDP increases by 1% per a quarter the demand for real broad money also increases by the same percentage per a quarter. These findings support the monetarist's claim that the income elasticity of broad money demand is equal to one. According to the quantity theory of money (QTM) this unitary income elasticity property is a necessary but not a sufficient condition for a constant velocity, which is in turn necessary to operate money expenditure multiplier process in the economy. On the other hand, unitary income elasticity is also important to regulate money supply as an intermediate target to achieve the final goal/goals (i.e. economic and price stability) via the monetary transmission mechanism.

The estimates pertaining to inflation and 91 days real Treasury bill rate (R91TB) in model 2 and 4 appear in theoretically expected signs and also they are statistically significant except the estimate of R91TB in model 2. For example, when the inflation increases by 1% per a quarter, the demand for real broad money decreases by 0.06%. It suggests that when the inflation goes

up people in Sri Lanka tend to substitute money for more real assets than the alternative financial assets. Furthermore, 1% increase in R91TB in model 4 causes to decrease real board money demand by 0.03% per a quarter in the long run.

Table 4: Estimation Results Obtained Using Granger's (1987) Two-step Method

Dependent variable: Logged of real broad money (LRM2t)				
Method: Engle and Granger (1987) two-step method for co-integration				
t-values are given in parenthesis				
Independent variables	Model-1	Model -2	Model-3	Model-4
LRGDP	1.06 (90.30)	1.05 (80.32)	1.05 (91.86)	0.90 (626.65)
LINF	-	-	-0.013 (-2.97)	-0.012 (-2.63)
R91TB	-	-0.0095 (-1.99)	-	-0.0068 (-1.46)
Constant	-1.86 (-12.30)	-1.70 (-10.39)	-1.76 (-12.20)	-
Trend	-	-	-	0.002 (10.07)
Error term in Granger's method:	I(0)	I(0)	I(0)	I(0)
Conclusion	Variables are co-integrated in levels in four models			

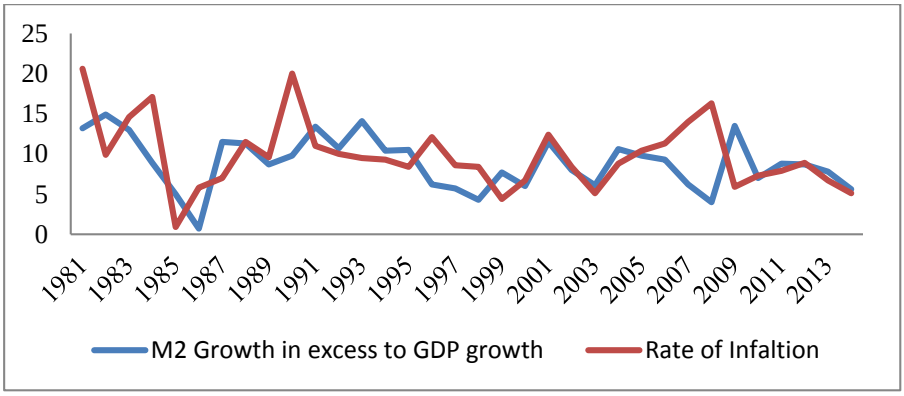
Source: Authors estimates based on Eviews version 5

The results obtained by employing Granger's method for the four above models are given in Table 4. It is worthy to note that results in Table 4 are almost compliance to those appearing in Table 3. Furthermore, it has been proven that when variables in levels are co-integrated in Engle and Granger (1987) method, the OLS estimates become super consistent. Therefore, as variables in all four models mentioned below are co-integrated, their estimates are super-consistent.

Estimated results in Table 4 confirm again the strong acceptance of the monetarists' argument that income elasticity with respect to broad money demand is equal to one.

In policy making point of view, it suggests that Central Bank should pay it attention to keep growth of money supply at a rate equal to real GDP growth rate to maintain the target of price stability. Excess growth of money supply relative to real GDP growth would result inflation in the economy. This follows the idea that the rate of inflation and the excess money growth over the real GDP growth must follow the same time path. This theoretical conclusion is true for Sri Lanka in most of the years during the study period except for the abnormal years where Sri Lankan economy was severely affected by global external shocks such as those were in 1989 and 2008. (See figure- 01).

Figure 1: Excess Money Growth over the Real GDP and the Rate of Inflation -1981-2014



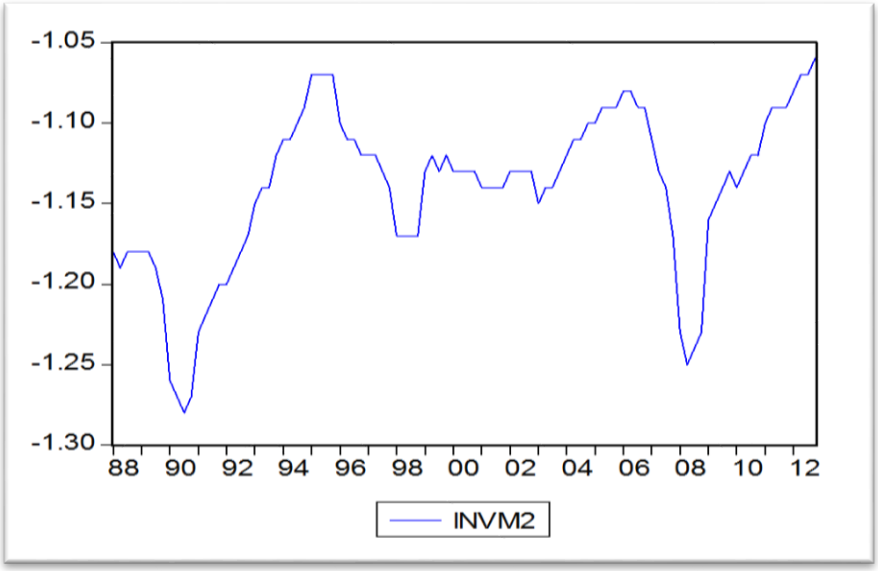
Source: Central Bank Annual Reports (Various years)

Over the recent past, the Central Bank of Sri Lanka continued to ease monetary policy package. The REPO and ReREPO rates, which are the main policy instrumental rates of the Central Bank, were gradually brought down to its historic lowest rate at 6.5 and 8.5 percent respectively. The SRR too reduced to 6 percent, which is the lowest ever recorded. As it can be seen from figure 1, an easy monetary policy has been implemented during the period from 2010-2013 and it caused to increase M2 growth, resulting nominal GDP to follow same path though at a lower rate.

Now, it is possible to test whether the inverse velocity of broad money is constant over time in the Sri Lankan context. This can be tested using the ADF procedure outlined before. To begin, it is useful to explore that the trend and behaviour in velocity of broad money supply in the study period concerned. Figure 1 presents the behaviour of inverse velocity of broad

money supply in Sri Lanka in the period from 1988: Q1 to 2012: Q4. It is very clear that although the inverse velocity of broad money supply fluctuates between -1.3 and -1.05, it shows a stationary time path over the period concerned. It means that the inverse velocity of broad money supply seems to be constant in the Sri Lankan country context. However, this needs to be statistically confirmed through an ADF test.

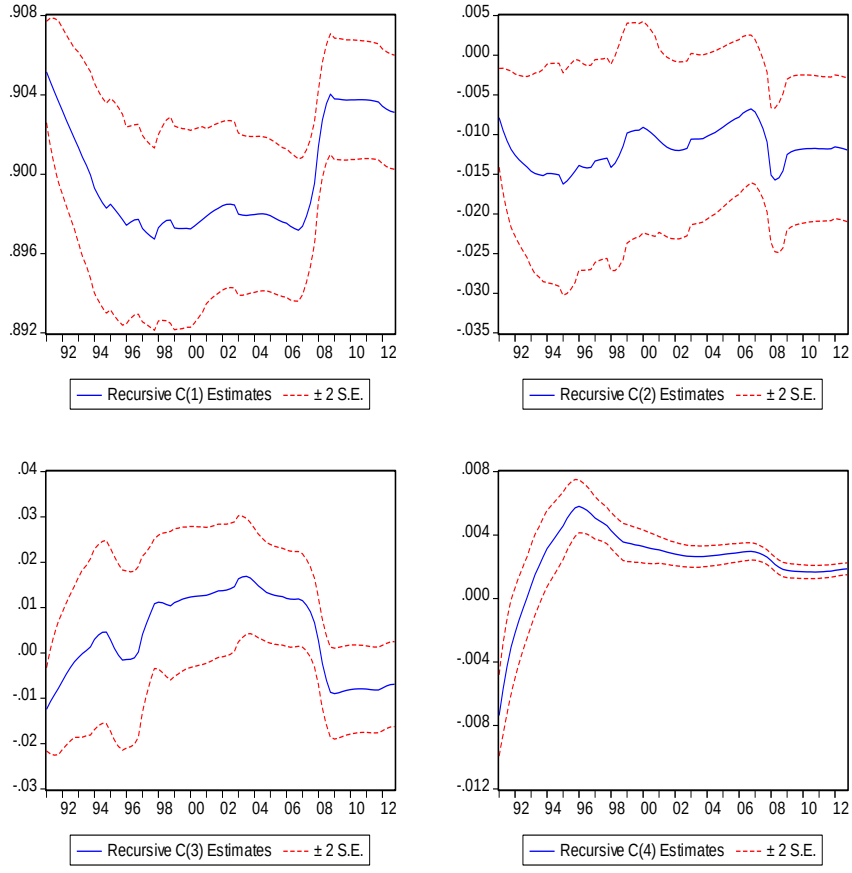
Figure 2: Inverse Velocity (LRM2-LRGDP) of Broad Money Supply (1988: Q1-2012: Q4) of Sri Lanka



Source: Authors' creation based on Central Bank data (various years)

The result of ADF test carried out on inverse velocity of broad money supply confirms that the null hypothesis of having a unit root is strongly rejected as calculated ADF value (-3.46) is greater than the ADF value at 5% significant level (-2.89). This means that the inverse velocity of broad money supply (hence velocity) of Sri Lanka is constant over the period concerned. Therefore, the monetarists' argument that the velocity of money needs to constant for the effective function of MTM is true with regard to the broad money supply in Sri Lanka.

Figure 3: Testing Stability of Broad Money Demand Function (Model 4) Based on Recursive Coefficients

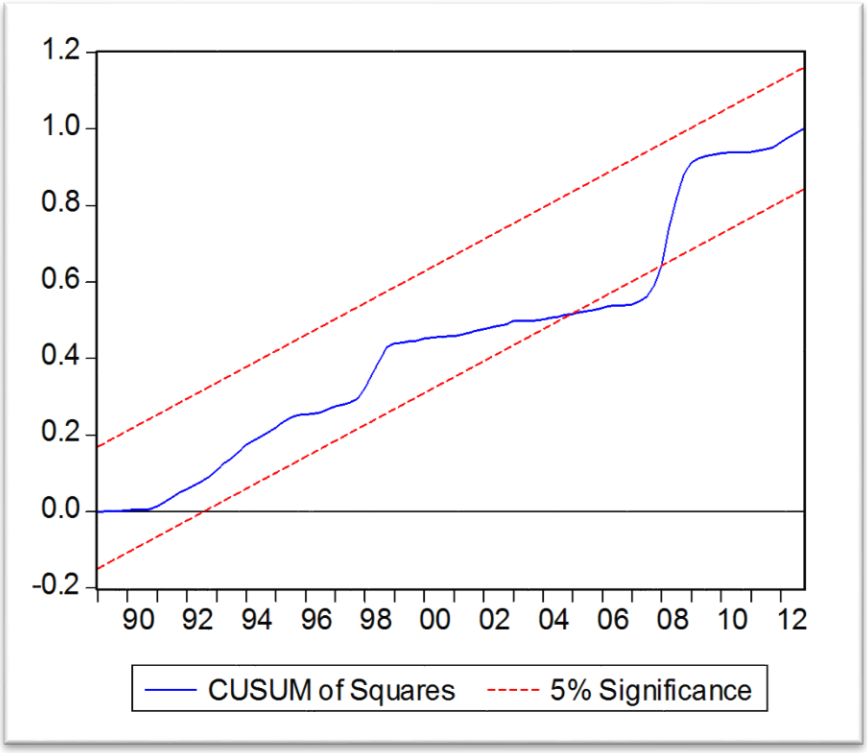


Source: Authors' creations based on Eviews version 5

The stability of the money demand function, which is a crucial requirement to make correct and reliable policy forecasts, is tested based on recursive coefficients and cumulative sum of squared residuals (CUSUM) of model 4 which was estimated using Granger's two-step approach to co-integration. Accordingly, the graph (a) in Figure 3 plots the recursive estimates of real income variable (β_1) from 1991: Q1 to 2012: Q4 while graphs (b) and (c) plots the recursive estimates attached to inflation (β_2) and 91 days real Treasury bill rate (β_3) for the same period respectively. Graph (d) in Figure 3 shows the plots of recursive estimates of trend variable. As only the third decimal value of all four recursive estimates have changed very marginally

and as all the estimated recursive coefficients in model 4 appear to lie within 2 standard error band over the whole sample period considered, it is possible to conclude that the broad money demand function (Model 4) holds the stability properties. Figure 4 shows the results function (Model 4) holds the stability properties. Figure 4 shows the results obtained in testing the stability of estimates attached to each variable included in broad money demand function based on recursive coefficients test.

Figure 4: Testing Stability of Broad Money Demand Function (Model 4) Based on Cumulative Sum of Squared Recursive (CUSUM) Residuals



Source: Authors' creations based on Eviews version 5

The Figure 4 depicts the plots of cumulative sum of squared recursive (CUSUM) residuals of model 4 and it also confirms the same result. Interestingly, as shown in Figure 2 the sudden change in the inverse velocity of broad money in the period from 2006 to 2008 is reflecting the temporary movement of CUSUM residuals out of the 5% significance band for the same period. This result shows a strong correlation between the velocity of money and the stability of money demand function.

CONCLUSIONS

This paper examined the validity of the monetarist version of money demand function for Sri Lanka using Johansen and Juselius (1990) Multivariate and Engle and Granger (1987) two-step methods for co-integration. The study found that the broad money demand in Sri Lanka is unitary income elastic and hence coincides with monetarists' version of money demand function. It reveals that the real demand for broad money decreases when the inflation rate increases. Similarly, increase in Treasury bill rate leads decrease in broad money demand. This implies that public in Sri Lanka tend to substitute money for real assets more than for the alternative financial assets during the high inflation. These findings are novel to the literature in Sri Lanka country context and thus will bring useful insight for monetary policy formulation. The study provides further evidence that the broad money demand function is stable with the constant income velocity over time. However, these results are completely opposed to the findings in Dharmarane's (2009) study where he established the notion that broad money demand (M2) is co-integrated with neither real income nor the interest rate.

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RESEARCH ARTICLES
Sri Lanka Journal of Economic Research
Volume 3 (2)
December 2015: 71-98
Sri Lanka Forum of University Economists

SLJER

WHY THE FERTILIZER SUBSIDY SHOULD BE REMOVED: KEY FACTORS THAT ACTUALLY DERIVE THE FERTILIZER DEMAND IN PADDY SECTOR OF SRI LANKA

Chatura Rodrigo
Lakmal Abeysekera

Abstract

This paper examines the factors affecting demand for fertilizer in paddy production in Sri Lanka. A panel-data analysis (1990-2011) reveals that demand for fertilizer is negatively affected by the price of fertilizer and the price of seed paddy and positively by the price of labour. Despite strong demand for fertilizer in commercial paddy production, the impact of the subsidy on demand is low. Results indicate that mechanization will prevent overuse of fertilizer and a seed paddy subsidy will ensure self-sufficiency in rice production. We recommend that the fertilizer subsidy be removed from non-commercial areas in the short-term and from commercial areas in the long-term.

Key words: Fertilizer demand, Fertilizer subsidy, Paddy production, Sri Lanka

Chatura Rodrigo
Lead author, Research Economist, Institute of Policy Studies (IPS), Colombo, Sri Lanka, Email: chatura_rodrigo@yahoo.com

Lakmal Abeysekera:
Co-author, Lecturer, Department of Management, Monash Business School, Faculty of Business and Economics, Caulfield Campus, Monash University, Melbourne, Australia, Email: lakmal.abeysekera@monash.edu,

INTRODUCTION

Many developing countries are facing the continual challenges in increasing their agricultural production. Concerns over food security have pushed governments to intervene in the sector, particularly providing input subsidies to farmers to ensure a higher and uninterrupted supply of agricultural commodities (Narayan & Gupta, 1991; Minot & Benson, 2009). Among many input subsidy schemes implemented, subsidies for fertilizer have undoubtedly been a major agricultural intervention for many developing countries (Ahmed, 1987; Baker & Hayami, 1976; Bayes, Parton & Piggott, 1985; Hadley & Tabor, 1998; Renfro, 1992), despite the enormous financial burden on the budget of governments of such countries (Narayan & Gupta, 1991; Mergos & Stoforos, 1997). Due to the availability of subsidized fertilizer, farmers have been found to overuse it, resulting in numerous negative environmental externalities (e.g., soil degradation, surface water pollution, and ground water pollution) and increased concerns about food security through subsidiaries (Manos, Begum, Kamruzzaman, Nakou & Papathanasious, 2007). As such, excess use of fertilizers in agriculture is found to be significantly impacted the economy, society and broader environment of a nation (Manos, Begum *et al*., 2007; Sharma, 2012).

As in many developing countries, subsidy of fertilizer is a major agricultural policy in Sri Lanka, with the paddy sector being the chief recipient. Rice is the staple food in Sri Lanka and the successive governments over recent decades have significantly provided fertilizer subsidies to farmers with the aim at increasing the paddy production (Gamawelagedara, Wickramasinghe & Dissanayake, 2011; Rajapaksa & Karunagoda, 2009). Since 2005, the fertilizer subsidy has accounted for 2-2.5% of total government expenditure, as the subsidy given for all three major fertilizer components: nitrogen (N), phosphorus (P) and potassium (K). Over the past three decades, the subsidy has significantly contributed to increasing paddy production, stabilizing the price of rice and in achieving self-sufficiency in the production of rice in Sri Lanka (Ekanayaka 2005; Weerahewa, Kodithuwakku & Ariyawardana, 2010). However, researchers conducted by Weerahewa *et al*. (2010) and the Ministry of Finance and Planning, Sri Lanka (2014) has raised the question about the effectiveness and sustainability of the subsidy due to farmers' overuse of subsidized fertilizer as well as using it for crops other than paddy. Furthermore, excessive use of fertilizer has raised fears about soil and water pollution and safety food (Tirado & Allsopp, 2012).

In response to the facts that financial burden, negative environmental externalities and concerns over food security, the government of Sri Lanka let to cut the fertilizer subsidy by 25% in its budget 2012-2013 (Ministry of

Finance and Planning, 2012). The main objective of reducing the subsidy was to encourage farmers to use more organic fertilizers. However, paddy farmers complained to the government about that their inability to shift to organic fertilizer at such short notice and they foreshadowed a possible increase in the price of rice. The government led to revise its fertilizer subsidy policy by adjusting the fertilizer subsidy reduction only to 10% in 2013-2014 budget (Ministry of Finance and Planning, 2013) and continue the revision for the financial year 2014- 2015 (Ministry of Finance and Planning, 2014).

Paddy cultivation is one of major sources of livelihood in Sri Lanka, providing employment for more than 1.8 million people. Therefore, in terms of ensuring the food security and reducing unemployment, the government is under constant pressure to continue with the agricultural subsidy programs. As in governments of most developing countries, the subsidy has become a politically sensitive issue in Sri Lanka too, as paddy farmers are the majority voter base (Thenuwara, 2003; Weerahewa *et al*., 2010, Jayne & Rashid, 2013) in the country. In this context, a clear understanding about the factors that determine the demand for fertilizer is necessary in evaluating the effectiveness of the fertilizer subsidy scheme implemented by the government of Sri Lanka.

Several studies (Ekanayake, 2005; Gunawardana & Oczkowski, 1992; Kikuchi & Aluwihare, 1990; Rajapaksa & Karunagoda, 2009) that attempted to examine the factors determine the demand for fertilizer in paddy cultivation in Sri Lanka. However, analysis of these studies have limited only to handful of factors that determine the demand for fertilizer, such as selling price of rice, price of labour, price of paddy output, and the quantity of paddy produced. Yet many other factors, such as the price of seed paddy, cost of machinery, cost of pesticides (Arriyagada, Sills, Pattanayak, Cubbage & Gonzales, 2010) and whether paddy cultivation is doing at a commercial or non-commercial level have not been found (Gilbert & Jayne, 2008). The gap results ineffectiveness of policy decision making to government of Sri Lanka.

Further research is required on seasonal usage of fertilizer in two main paddy farming seasons[1] in Sri Lanka as *Maha* and *Yala*. Fertilizer usage is differing in the two seasons: the '*Maha* 'season consumes more fertilizer than the '*Yala*' season because more area is cultivated during the former

[1] Maha and Yala are synonymous with the two monsoonal periods in Sri Lanka. The Maha season occurs between the months of September to March and is dependent on rainfall from the north-east monsoon. The Yala season is effective during the period from May to August and is cultivated during the south-west monsoon. The particular season is defined by when the crop is sown and harvested.

(Ekanayaka, 2005). Therefore, data from both seasons need to be considered in accounting for this difference.

In addition to the Sri Lankan country context, this study will provide a template for other developing countries in the South-Asian region for estimating demand for fertilizer in agricultural production. For example, economies in the region such as Nepal, India and Pakistan are also highly agriculture-based undertake planting on a seasonal basis (Hutabarat & Ranawana, 2003). Input subsidies for fertilizer are thus a priority on the development agendas of these governments (Mujeri, Shahana, Chowdhury & Haider, 2012). While the empirical model developed in this study is focused on the demand for fertilizer in paddy cultivation, it can be used to examine the determinants of demand for fertilizer in other cereal crops such as wheat, maize and millet, grown in many South-Asian countries (Dev, 2013; Wiggins & Brooks, 2010).

This paper is organized as follows. In Section 2, the background to paddy cultivation in Sri Lanka, including use of fertilizer and its determinants, is provided. The theoretical framework used in deriving the fertilizer demand function is shown in Section 3. Section 4 provides the estimation strategy used to empirically test the demand for fertilizer. Section 5 presents the results from and discussion of the regression analysis. Finally, Section 6 outlines the key policy recommendations for the government of Sri Lanka: control the overuse of fertilizer, remove the financial burden on the government budget, and ensure self-sufficiency in the production of rice.

Fertilizer Subsidies

(a) *The Sri Lankan context*

The fertilizer subsidy has been a significant part of government expenditure in Sri Lanka since 1962. There are three main nutrients in paddy fertilizer: nitrogen (N), phosphorus (P) and potassium (K). Nitrogen (N) is provided through urea, potassium (K) is provided through murate (or muriate) of potash (MoP; KCl) and phosphorus (P) is provided through triple superphosphate (TSP) (Ekanayaka 2005; Rajapaksa & Karunagoda, 2009; Weerahewa *et al.*, 2010). From 1962 to the present, successive governments have provided the subsidy either as a full subsidy containing all three nutrients, or as a urea-only fertilizer subsidy (i.e., providing only nitrogen in $CO(NH_2)_2$, out of these three required elements). A full subsidy was provided during the period from 1962 to 1989. The rates of subsidization, however, changed during the early 1980s with highly volatile prices of

fertilizer in the world market. The policy discouraged the farmers in usage of fertilizer and the problem was addressed by the government introducing the price sealing to paddy sector. Subsidies were not entertained for the period between 1990 and 1994 because of increasing international prices of fertilizer and oil. A full fertilizer subsidy was reintroduced in 1995 and continued until 1996. However, only urea was covered under the fertilizer subsidy between 1997 and 2004. Since 2006, the concurrent government a full fertilizer subsidy has been provided covering all three types of nutrients. In budget for 2015-2016 the fertilizer subsidy converted into a voucher system. Therefore, the fertilizer subsidy in Sri Lanka can be clearly categorised into three groups of policies: (1) a full subsidy 1962-1989, 1995-1996 and from 2006 to 2015 (2) no subsidy from 1990 to 1994; and (3) a urea-only subsidy from 1997 to 2005.

Farmers are eligible to apply for the fertilizer subsidy provided they have a legal title to their paddy lands (Ekanayake, 2005; Rajapaksa & Karunagoda, 2009; Rodrigo, 2013; Weerahewa *et al*., 2010). Fertilizer is distributed by the Department of Agriculture through Agrarian Service Centres where agrarian service officers are responsible for certifying farmers' eligibility to receive the subsidy. In 2014, the government of Sri Lanka annually spends around SLR50 billion (Sri Lankan Rupees) to import 750,000 tonnes of fertilizer. Over the last nine years the government has spent SLR6.6 trillion (approximately USD50 billion) on importing fertilizer. With the scheme, a 50kg bag of fertilizer is provided at a subsidised rate of SLR350. An unsubsidized bag of 50kg fertilizer would cost approximately SLR4700 (Ministry of Finance and Planning, 2013; 2014; Ponweera & Premaratne, 2011; Weerahewa *et al*., 2010; Wiggins & Brooks, 2010). However, there is a growing debate on whether or not the fertilizer subsidy has been reached towards its intended outcomes: yield increase, reduction of negative environmental externalities, and improved food safety (Ministry of Finance and Planning, 2014).

In a research study by Ekanayake (2005) found that a positive relationship between the average annual fertilizer consumption by farmers and paddy production in the study period (1962. Findings by Ekanayake (2005) confirmed again by the studies of Department of Census and Statistics, Sri Lanka (2011) and the World Bank (2007), concluding "the average annual paddy production in Sri Lanka has increased over time with increasing use of fertilizer". By contrast, the study conducted by the Department of Agriculture (2011) on fertilizer subsidy programme since 2005 2010 found that a decreasing trend in average use of fertilizer by the paddy farmers. This opposite views can probably to be explained with the fact that the statistics of the Department of Agriculture are restricted to only several paddy-producing areas and do not cover the whole country. We address this

limitation by focusing our analysis on panel data covering all major paddy-producing areas of Sri Lanka.

Several researchers (Ekanayaka, 2005; Rajapaksa & Karunagoda, 2009; Weerahewa *et al.*, 2010) have investigated fertilizer demand in Sri Lanka using two variables of paddy production and fertilizer usage in the period from 1990 to 2005. The current study examines the fertilizer demand in Sri Lanka extending the data for the study period from 2005 to 2011.

Table 1. Annual average paddy production and fertilizer usage

Year	Average fertilizer use (Kg/Acre)	Average price of fertilizer (SLRs/Kg)	Average annual paddy production (Kg/Acre)
1990	136.6	9.35	1950.6
1991	133.8	9.79	1928.8
1992	141.0	10.29	2030.3
1993	132.2	10.95	1943.0
1994	117.5	12.08	1955.7
1995	144.8	11.58	2089.6
1996	155.2	14.74	1895.1
1997	144.0	15.51	1904.2
1998	157.0	9.88	2109.3
1999	154.0	8.13	2156.1
2000	154.1	9.60	2188.8
2001	156.6	10.93	2075.0
2002	164.2	10.31	2107.0
2003	174.0	10.88	2266.0
2004	174.9	11.52	2183.8
2005	166.6	11.62	2151.1
2006	169.9	11.50	2178.9
2007	173.0	11.61	2195.1
2008	162.5	12.88	2176.0
2009	172.2	11.70	2134.5
2010	180.3	11.18	1913.2
2011	179.3	11.82	1758.9

Source: Department of Agriculture (2011)

Table 1 shows the average rice production and fertilizer usage from 2000 to 2011. The data are aggregated to represent both cultivating seasons, as well as all the major paddy-producing administrative districts, including Anuradhapura, Pollonnaruwa, Kurunegala, Hambantota and Kalutara. Amongst, Anuradhapura, Pollonnaruwa and Kurunegala can be considered as the commercial paddy-producing areas since in these areas the paddy farming is a farmer's primary livelihood activity from which the majority of

the household's income is derived. Furthermore, these commercial paddy-producing areas are accounting for more than 80% of the total paddy production in the country. It means that paddy production in non-commercial areas is mainly used by farmers' households themselves for self-consumption (Gamawelagedara *et al*., 2011; Thenuwara, 2003).

As shown in Table 1, lower usage of fertilizer is recoding from 1990-1994 when the subsidy has not been provided for paddy cultivation. In contrast, with the advent of the full subsidy in 1995 usage amount of fertilizer has increased. Since 1997, average use of fertilizer by farmers has continually increased with the government dual policy to provide either a urea-only or a full subsidy for paddy farmers. Data in table 1 further evidence that corresponding to the higher fertilizer used, paddy production has also increased with the subsidy schemes. However, the price of fertilizer does not necessarily affect an increasing or decreasing production, and it is strongly controlled by the fertilizer subsidy scheme.

(b) *Determinants of fertilizer demand*

Fertilizer is an essential input to the agricultural production process. Demand for inputs in that process is determined by the prices of other competing inputs, quantities of other outputs (either plant- or animal-based), and various cost components (Arriagada, Sills *et al*., 2010; Mergos & Stoforos, 1997; Rabbi, 1986). Similar to any other agricultural production process, fertilizer is a major input for paddy production. Many factors determine the demand for fertilizer in paddy production with the main factor being the price of fertilizer (Ekanayaka, 2005; Rajapaksa & Karunagoda, 2009). In addition, demand for fertilizer is determined by the price of labour, the price of seed paddy, the quantity of paddy produced, and the area of paddy production (Ekanayaka, 2005; Gamawelagedara *et al*., 2011; Rajapaksa & Karunagoda, 2009). Paddy production is also subjected to many cost factors such as land preparation, water management, weed management, pest management and mechanization (Arriagada, Sills *et al*., 2010; Gamawelagedara *et al*., 2011). Paddy can be produced in commercial and non-commercial areas, with the demand for fertilizer being higher in the former (Ekanayaka, 2005; Gunawardana & Oczkowski, 1992; Kikuchi & Aluwihare, 1990; Rajapaksa & Karunagoda, 2009).

According to Ekanayaka (2005), the demand for fertilizer is likely to be dependent upon its price and therefore a significant difference may exist in demand when the price is subsidized. However, using a simple regression method to estimate demand functions for the three main fertilizers subsidised, Ekanayaka (2005) found that changes in the price of fertilizers and the price of paddy had little impact on the demand for fertilizer. Despite the low significance attached to both of these factors, he found the impact of

the latter to be greater than the former on the demand for fertilizer. Based on these findings, Ekanayaka (2005) concluded that the fertilizer subsidy should be gradually removed and public policy around it be based on the price of paddy output.

While raising a number of valid inferences, Ekanayaka's (2005) study encompassed a number of limitations. First, despite using data from 1981 to 2004, his study contained only 24 observations after sample adjustments. As a consequence, the statistical and explanatory power of his regression analysis was low. Second, Ekanayake only examined fertilizer price, the farm gate price of paddy, and the area under irrigation. Key determinants, such as the price of labour, the price of seed paddy, and the quantity of paddy produced that have been found to influence the demand for fertilizer, were not considered in his analysis. Furthermore, Ekanayake did not look at differences in fertilizer demand between commercial and non-commercial paddy-producing areas, despite established differences in the demand for fertilizer between these areas (Rajapaksa & Karunagoda, 2009). Ekanayaka used data that amount of issues of fertilizer to capture the demand for fertilizer, as opposed to the actual amount of fertilizer used by farmers, assuming that issued fertilizer is used only for paddy farming. However, this may have overestimated demand for fertilizer because paddy farmers have been found to use the subsidized fertilizer for crops other than paddy (Ministry of Finance and Planning, 2014; Weerahewa *et al*., 2010).

In another study, Rajapaksa and Karunagoda (2009) argued that demand for fertilizer is depending upon such factors as its price, the price of labour, the price of seed paddy, and the cost of machinery (i.e., a proxy variable for the degree of mechanization). They employed a Translog profit function to derive an input demand function to examine the factors that affect the usage of fertilizer. Rajapaksa and Karunagoda's (2009) findings consistent with the findings of Ekanayaka (2005), where the price of seed paddy had a higher impact on fertilizer demand compared to the absolute price of fertilizer. They also found that fertilizer usage does more responsive to the price of paddy in non-commercial areas compared to the commercial areas. Based on the results of their study, Rajapaksa and Karunagoda (2009) concluded that fertilizer subsidies is more important in determining the demand for fertilizer than that of public policy focused on output prices of paddy. While making an important contribution to knowledge of factors that affecting the demand for fertilizer in Sri Lanka, Rajapaksa and Karunagoda's (2009) study evolves with a number of limitations. First, their research relied on data published by the Department of Agriculture from 1990 to 2006, and hence did not account for fluctuations in the demand for fertilizer based on the subsidy scheme implemented after 2006 by the subsequent governments. Second, Rajapaksa and Karunagoda (2009) used only 32 observations from 1990 to 2006 in their time series analysis, which

may have reduced the explanatory power of their regression models. Further, they did not attempt to look at the impact of the subsidy on fertilizer demand in including a control for fertilizer policy. The demand for fertilizer can fluctuate as a consequence of the subsidy (Ekanayaka, 2005; Weerahewa *et al.*, 2010). Therefore, it is important to control for such fluctuations, including a dummy variable in the regression analysis to represent the policy changes, which is an analytical procedure followed in this study.

While empirical studies examining determinants of the demand for fertilizer in Sri Lanka are limited, however, there are several studies can available from India, Bangladesh, Indonesia and a few African countries that contributing some empirical evidences. For example, Croppenstadt, Memeke and Meschi (2003) used a double hurdle fertilizer adoption model to assess the adoption of fertilizer in Ethiopia in cultivating cereals. Rather than using country-level data, they used data collected from over 6000 farming households. They found in their study that the level of formal education of the farmers, the size of the household, and the value-to-cost ratios of the farm operations have a significant impact on fertilizer demand. Their study includes many micro-level observations which increase the explanatory power of the regressions, but not included factors such as the fertilizer price, seed price, output price and quantity of production, which may have provided an alternative explanation for the adoption of fertilizer.

Gilbert and Jayne (2008) examined fertilizer demand for Malawi farmers, where fertilizer was distributed by both the public and private sector. They found that the fertilizer subsidy negatively affected on the purchase of fertilizer through commercial markets. They argued that commercial market for fertilizer was being displaced by the introduction of fertilizer subsidies. In Sri Lanka, the distribution of fertilizer for paddy cultivation under the subsidized price is predominantly done through the government fertilizer secretariat. As such, only a negligible amount of fertilizer is purchased from the private sector, even if there is a significant shortage in the supply of fertilizer through the public sector (Ekanayaka, 2005). However, official data collected by the Department of Agriculture of Sri Lanka on the cost of cultivation and demand for fertilizer does not differentiate between the public and the private sector (Rajapaksa & Karunagoda, 2009). Nevertheless, one of the major findings of Gilbert and Jayne's (2008) study was that fertilizer subsidies should be targeted at farmers who are engaged in extensive agriculture with higher inputs of fertilizer. This finding is relevant for Sri Lanka, given that the fertilizer subsidy before 2015 is equally accessible to all farmers, irrespective of whether they undertake paddy cultivation in a commercial (i.e., extensive cultivation of paddy) or non-commercial (i.e., lower cultivation of paddy) area. As noted earlier, research undertaken by Ekanayaka (2005) and Rajapaksa and Karunagoda

(2009) did not investigate the relationship between the land extent of cultivation and demand for fertilizer. Our analysis investigates this unexplored relationship and thus provides an initial step in the discourse surrounding public policy development in relation to the targeting of fertilizer subsidies according to the area of cultivation in Sri Lanka.

In explaining fertilizer usage in Bangladesh, Manos, Begum *et al*. (2007) found remarkable negative relationship between fertilizer prices and the demand for fertilizer. They suggested that increasing fertilizer prices will decrease farm income and farmers will ultimately reduce the demand for fertilizer. Finally, Manos, Begum *et al*. (2007) found that increasing fertilizer prices drove farmers to change their farm plans, resulting in the introduction of less fertilizer-intensive crops and a reduction in labour usage. However, Manos, Begum *et al*. did not examine the impact of the price of labour on the use of fertilizer. Labour remains an essential factor of production in the paddy sector in developing countries, despite its importance receding in recent decades due to mechanization (Department of Census and Statistics, 2013; Nawaratne, 2013). By examining the influence of the price of labour on demand for fertilizer, the current study contributes to current knowledge on public policy development in relation to fertilizer subsidization within the context of a developing nation. Deriving input demand functions from a production process is well-established in the economic literature (Arriyagada, Sills *et al.*, 2010; Rajapaksa & Karunagoda). We therefore now focus our attention on the theoretical explanation for derivation of a fertilizer demand function. We then present the empirical framework for estimating the demand for fertilizer.

THEORETICAL BACKGROUND

Consistent with previous research we used production and profit maximization theories in deriving the input demand function for fertilizer (Acheampong & Dicks, 2012; Arriagada, Sills *et al*., 2010; Ball, 1988; Lau & Yotopoulos, 1972; Mergos & Stoforos, 1997; Sidhu & Baanante, 1979; Yotopoulos, Lawrence & Wuu-Lon, 1976).

If we assume that farmers behave rationally, the input demand function, such as one for fertilizer demand, can be derived from a normalized profit function which can take the following form:

$$\pi = PQ - WX \qquad (1)$$

The production of paddy which uses fertilizer as an essential variable input will take the form:

$$Q = f\ (W, Z) \tag{2}$$

In equations (1) and (2), π is the farm profits, Q is the quantity of rice produced, P is the price of rice, X is the quantity of variable inputs and W the price of variable inputs. Z is the vector of fixed factors of rice production. Both profits and the prices of variable inputs are normalized by the price of paddy output. Based on these, a profit maximization problem can be written as:

$$Max\ PQ - WX\ Subject\ to\ Q = f(X, Z) \tag{3}$$

Solving the profit maximization problem shown in equation (3) will yield a set of input demand and output supply functions, as shown by equations (4) and (5):

$$X = x\ (P, W, Z) \tag{4}$$

$$Q = q\ (P, W, Z) \tag{5}$$

The profit maximizing input and output levels can be derived by substituting the relevant input demand and output supply functions expressed by equations (4) and (5) back to the profit function explained by equation (1). It can be explained as:

$$\pi = P\ q(P, W, Z) - Wx(P, W, Z) \tag{6}$$

Input demand function can be obtained by differentiating the profit function (equation 6) with respect to input price X, and the output supply function can be obtained by differentiating the same function with respect to output price P. The resulting functions are illustrated below as equations (7) and (8):

$$X_I^* = -\frac{d\pi}{dw_I} = X^*\ (\mathrm{P, W, Z}) \tag{7}$$

$$Q^* = \frac{d\pi}{dp} = Q^*\ (\mathrm{P, W, Z}) \tag{8}$$

However, in this study we employed a Cobb-Douglas functional form to describe the technology used in the production of rice in Sri Lanka. Therefore, the production technology shown in equation (2) will take the form explained in equation (9):

$$Y = A \prod_{i=1} n \, X_i^{\beta i} \qquad (9)$$

where $\beta_i > 0$ and I = 1, 2...n

The Cobb-Douglas production function will result in a log-log fertilizer demand function. This function was then estimated, using a single function Ordinary Least Square (OLS) procedure. Use of the Cobb-Douglas functional form allowed us to estimate the demand elasticity of independent variables directly. A single equation OLS procedure is more likely to provide accurate and reliable estimates, especially with a small sample, compared to other estimation procedures (Arriagada, Sills *et al*., 2010; Griffin, Montgomery & Rister, 1987). Chembezi (1990) highlighted possible statistical concerns over the simultaneity of fertilizer demand and prices. However, in Sri Lanka, whether it is the subsidized price or the market price, fertilizer prices are announced in advance of the cultivation season. Therefore, in a given time period, farmers will decide on the amount of fertilizer to be used based on the already known fertilizer prices, and hence are not affected by the local demand for fertilizer of the area (Arrigada, Sills *et al*., 2010).

EMPIRICAL MODEL

In the literature, different methods have been used by the researchers to estimate fertilizer demand functions. Over the last three decades, numerous researchers have consistently employed the profit function approach as a mechanism to estimate demand for fertilizer in both developing (Abrar & Morrissey, 2006; Arriagada, Sills *et al*., 2010; Bapna *et al*., 1984; Fulginiti & Perrin, 1990; Lau & Yotopoulos, 1972; Sidhu & Baanante, 1979; Sidhu & Baanante, 1981; Yotopoulos *et al*., 1976) as well as developed economies (Gunjal & Earl, 1980; Mergos & Stoforos, 1997). Following these researchers, the profit function approach was used in empirically estimating the demand for fertilizer in Sri Lanka. Adoption of the Cobb-Douglas functional form for production technology allowed us to derive an input demand function for fertilizer as depicted in equation (10). Following the arguments postulated by Arriagada, Sills et al. (2010), Griffin *et al*. (1987), and Mergos and Stoforos (1997), we used a single function approach in

estimating the stated empirical relationship, as opposed to a system of equations.

The empirical form of the fertilizer demand function can be depicted as follows:

$$\text{In F} = \alpha + \beta D_c + \gamma \text{ In Y} + \sum_{i=1} 3\ \delta_i \text{ In } W_i + \sum_{j=1} 4\ \vartheta_j \text{In } Z_j + \epsilon. \quad (10)$$

In equation (10) F is the fertilizer usage based on the major paddy-producing area, Y is the paddy output, Z_1 is the price of rice fertilizer, Z_2 is the price of labour, Z_3 is the price of seed paddy, W_1 is the cost of machinery, W_2 is the cost of materials, W_3 is the cost of pesticides, D_{c1} is the dummy variable to represent the subsidy years (subsidy dummy) and D_{c2} is the dummy variable to represent commercial paddy-producing areas (area dummy). The α, β, γ, δ, and ϑ are estimated parameter coefficients and ε is the random error. Fertilizer prices, labour prices and seed paddy prices are expected to have a negative sign. Consistent with cost minimization theory, the rice output is expected to have a positive sign. The different cost components (i.e., cost of machinery, cost of materials and cost of pesticides) are expected to have a negative sign. The dummy variable on the subsidy is also expected to have a positive sign, where fertilizer usage is expected to be high when the subsidy is provided. Finally, the dummy variable on area is expected to have a positive sign where commercial paddy-producing areas are expected to use more fertilizer than non-commercial areas (Arriagada, Sills *et al*., 2010; Ekanayaka, 2006; Rajapaksa & Karunagoda, 2009).

This study used secondary data collected and published by the Department of Agriculture, Sri Lanka. The data is focused on the costs associated with the cultivation of paddy and are based on the major paddy-producing areas reflecting the two major cultivating seasons: '*Yala*' and '*Maha*'. For each major paddy-producing area, the Department conducts a bi-annual farm household survey based on a random sampling method, and data published at an aggregated level in area wise. The selected major paddy-producing areas have evolved over the years. Since 2010, data have been available for 15 major paddy-producing areas. Data on seven major paddy-producing areas have been consistently available since 2000. However, this number is reduced to only five such areas once data are considered from 1990. Our focus on fertilizer demand is from 1990. Therefore, the data we used in our analysis are based on five major paddy-producing areas: Anuradhapura, Pollonnaruwa, Hambantota, Kurunegala and Kaluthara. As explained earlier, we used the classification suggested by Gamawelagedara *et al*., (2013) and Thenuwara (2003) in categorizing these into commercial and non-commercial paddy-producing areas.

The data is organised into a panel data architecture. Balanced panels are being used and paddy producing area is the panel identifier. Fixed and random effect regression models are being run by STATA.

RESULTS AND DISCUSSION

This research used fertilizer consumption and cost of production data for the paddy sector in Sri Lanka from 1990-2011. It is the first study focused on Sri Lanka to examine data from 2005 onwards with the new fertilizer subsidy scheme was introduced in the period under study. Initially we used a fixed effect panel data model in estimating a direct fertilizer demand function. The Hausman test was conducted to determine the fact that whether a fixed effect or random effect model was more appropriate for our analysis. Results of the Hausman test (see Appendix A) supported the use of a fixed effect model. However, the area dummy variable could not be used in a fixed effect regression analysis, since for a given panel the dummy variable did not change. Therefore, the area dummy variable was excluded from the fixed effect regression model. In order to address this issue, a random effect model was employed with the area dummy variable controlling for fertilizer demand among commercial and non-commercial paddy farming areas.

Price variables in input demand systems tend to have a lower variation. Therefore, it is recommended to normalize the input prices and profits using the price of output (Arriagada, Sills *et al*., 2010). In our regression, we normalized the price of fertilizer, price of labour, and the price of seed paddy, using the price of paddy output. In panel data regressions it is essential to establish that data are stationary. Therefore, we performed the Harris-Tzavalis (HT) test for stationary recommended by STATA for panel data (Harris & Tzavalis, 1999; Hlouskova & Wagner, 2005). All the variables used in the regression analysis showed stationary properties. However, the HT test was significant only at the 90% significance level for the price of fertilizer and cost of machinery variables. Therefore, as recommended by Harvey and Trimbu (2008) and Hodrick and Prescott (1997), the Hodrick–Prescott (HP) filter was used to improve the level of significance of the HT test to the 99% significance level. Consequently, all variables used in the regression were found to be stationary and the HT test results were significant at the 99% significance level.

Table 2 provides the descriptive statistics of the variables used in the regression analysis. The coefficient of variations suggested enough variations for the variables to be used in the regression analysis.

Table 2. **Descriptive Statistics of the Variables Included in the Regression**

Variable	Description	Mean	Standard deviation	Coefficient of variation (%)
F	Fertilizer demand (Kg/Acre)	160.17	33.5	20.93%
Y	Paddy output (Kg/Acre)	1953	479.1	24.53%
Z1	Price of fertilizer (Rs/Kg)	1.25	1.1	93.46%
Z2	Price of labor (Rs/Man-days)	21.54	4.5	20.89%
Z3	Price of seed price (Rs/Kg)	1.67	0.27	16.13%
W1	Cost of machinery (Rs/Acre)	4721.51	3396.5	71.93%
W2	Cost of materials (Rs/Acre)	4478.80	2172.6	48.50%
W3	Cost of pesticides (Rs/Acre)	584.47	533.8	91.33%
D1	Subsidy dummy variable =1 if farmers were given a fertilizer subsidy	0.77	0.42	-
D2	Area dummy variable = 1 if the area is a commercial paddy farming area	0.60	0.49	-

Source: Based data collected from Department of Agriculture (2011)

The price of fertilizer was measured through the aggregate and average unit price of fertilizer that farmers face in a particular area for the '*Yala*' and '*Maha*' cultivating seasons. Farmers require to buy fertilizer from commercial fertilizer outlets exception with fertilizer subsidy. In such instances, the unit price that farmers paid varied, based on the type of fertilizer they bought and the proximity of the commercial fertilizer outlet to Colombo (i.e., the commercial capital of Sri Lanka). In a non-subsidy situation (i.e., 1990-1994), the commercial fertilizer outlets located far from Colombo would have a higher price, reflecting the additional transportation costs. Therefore, there is sufficient variation in the fertilizer prices among paddy-cultivating areas. Cost of machinery will vary based on the type and the brand of the machinery that farmers use for farming. For example, the

cost of machinery would vary depending on whether farmers used a four-wheel or a two-wheel tractor for ploughing. Furthermore, the cost of machinery would be the proxy for level of mechanization (Rajapaksa & Karunagoda, 2009). That is, higher allocations to machinery refer to higher mechanization. Cost of materials (other than fertilizer) and cost of pesticides will also vary according to the type and brands farmers used. For example, farmers in a certain area during a given cultivating season might use expensive and broad-base pesticides, depending on the type of pest attack experienced.

Table 3. Regression Results

Variable	Data from 1990-2011		Data from 1990-2005	
	Fixed effect (Model A)	Random effect (Model B)	Fixed effect (Model C)	Random effect (Model D)
Price of fertilizer	-0.232 (0.000)***	-0.224 (0.000)***	-0.297 (0.000)***	-0.296 (0.000)***
Price of labour	0.154 (0.091)*	0.190 (0.034)**	0.166 (0.118)	0.177 (0.084)*
Price of seed paddy	-0.197 (0.096)*	-0.279 (0.014)**	-0.272 (0.065)*	-0.259 (0.068)*
Quantity of output	0.152 (0.077)*	0.309 (0.000)***	0.304 (0.003)***	0.320 (0.000)***
Cost of machinery	-0.097 (0.101)	-0.115 (0.050)**	-0.152 (0.001)***	-0.146 (0.001)***
Cost of materials	0.213 (0.000)***	0.234 (0.000)***	0.281 (0.001)***	0.279 (0.000)***
Cost of pest management	-0.064 (0.092)*	-0.051 (0.157)	0.072 (0.174)	0.078 (0.107)
Subsidy dummy	0.074 (0.067)*	0.056 (0.157)	0.006 (0.991)	-0.007 (0.877)
Area dummy		0.103 (0.002)***		0.174 (0.000)***
R square overall	0.4690	0.5383	0.5215	0.6168

*** = 1% significant level, **=5% significant level, *=10% significant level

Source: Based data collected from Department of Agriculture (2011)

Table 3 shows the results of the regression analyses. Model A represents the fixed effect regression results, using data from 1990-2011. As expected, we found the price of fertilizer have a negative and statistically significant relationship with the demand for fertilizer. According to our results, a 1%

increase in the price of fertilizer would decrease the demand for fertilizer by 0.23%.

As it was expected, the price of seed paddy also had a negative as well as significant relationship with the demand for fertilizer, that is, a 1% increase in the price of seed paddy was found to decrease the amount of fertilizer usage by 0.19%. The amount of seed paddy was found to be directly related to paddy yield. When the price of seed paddy increased, farmers either reduced the area cultivated or the intensity of cultivation (i.e., the number of plants per acre) or used organic fertilizer, all actions that reduced paddy yield. Given that the rice varieties cultivated in Anuradhapura, Pollonnaruwa, Hambantota, Kurunegala and Kaluthara are mainly new improved varieties and hardly respond to organic fertilizers (Gamawelagedara *et al*., 2011; Rodrigo, 2013), it is important that the seed paddy prices are maintained at a lower price to sustain consistent paddy production.

Furthermore, there is remarkable positive relationship between paddy output and demand for fertilizer. For example, 1% increase in the amount of paddy output was found to result in a 0.15% increase in the use of fertilizer. Increased output has the potential to attract higher farm profits, which in turn allows farmers to allocate more money for fertilizer, especially if the subsidy is not provided. Therefore, it is important to find methods which improve the yield but utilize lesser amounts of chemical fertilizers since high chemical fertilizer use has been found to cause negative environmental externalities or higher opportunity cost (e.g., soil and water pollution) and impose financial pressure on the government (Ministry of Finance and Planning, 2013; Tirado & Allsopp, 2012). One such method is to utilize high-yielded paddy varieties. While farmers are using such varieties at present, more research is needed to explore additional varieties that are more fertilizer-responsive (Senaratne & Rodrigo, 2014; Rodrigo, 2013). As suggested by Nawaratne (2013) alternative strategy that can be employed to reduce dependency on chemical fertilizer is to introduce more mechanization into industry. Mechanization would increase farm productivity while limiting the use of inputs such as fertilizer and labour.

Cost of pest management was found to have a negative and significant relationship with the demand for fertilizer. For example, 1% increase in the cost of pest management will decrease the usage of fertilizer by 0.64%. Pest attacks can target paddy plants at any stage of their growth. Farmers use fertilizer mainly in the early stages of paddy cultivation, and, once the plants are established, fertilizer is not required. Therefore, use of fertilizer and pest management correlate mainly during the early stages of plantation. Early pest attacks will give the farmer a clear idea about the potential future performance of paddy cultivation. As such, once paddy cultivation is

affected by pests in its early stages, farmers will be discouraged from using successive rounds of fertilizer in the future, as the potential of paddy cultivation is decreased. That is, the opportunity cost of applying more fertilizer under such circumstances is higher than the potential gains from the yield.

Contrary to our expectations, the price of labour had a positive and significant relationship with the demand for fertilizer. For example, 1% increase in the price of labour was found to increase the demand for fertilizer by 0.15%. We expected farmers to use less fertilizer when the price of labour increased, as a higher labour price would decrease the amount of labour employed and possibly change the farm management plan (Manos, Begum et al., 2006). Labour is increasingly becoming a scarce resource for paddy farming in Sri Lanka due to internal migration of labour from rural (i.e., where paddy is cultivated) to urban areas and aging labour force (Nawaratne, 2013) and therefore, farmers who depend on hired labour are likely to maximize the investment they have made in labour by utilizing more fertilizer. This could potentially lead to an overuse of fertilizer, resulting in a number of negative environmental externalities, such as water and soil pollution (Weerahewa *et al*., 2010). Therefore, it is important that the price of hired labour is maintained at an affordable level to prevent overuse of chemical fertilizers.

Surprisingly, our results indicate that an increase in the cost of materials will also push farmers to use more fertilizer. In particular, a 1% increase in the cost of materials was found to increase the demand for fertilizer by 0.21%. Cost of materials here excludes fertilizer, seed paddy and pesticides. Therefore, it mainly consists of the cost of weedicides and any other material, such as paddy husks, coir dusk, ropes, etc. Applications of weedicides have the potential to destroy micro and macro organisms (Edmeades, 2003). As such, once weedicides are applied, farmers tend to use more fertilizer to rejuvenate the damaged soil in the paddy land. Similar to increased labour prices, increased material costs will also result in the overuse of fertilizer. One possible way to prevent this from happening is to adopt cultivation methods that facilitate low-cost manual weeding and the prevention of weeds. For example, use of dry sowing methods will prevent the emergence of weeds during the early stages of paddy planting (Senaratne & Rodrigo, 2014).

The subsidy dummy variable, which represents the policy decisions on the fertilizer subsidy, had a positive and significant relationship with the demand for fertilizer, implying that farmers tend to use more fertilizer when the subsidy was given. Results suggest that, on average, farmers increase the use of fertilizer by 0.74% when the fertilizer subsidy is given. Therefore, the fertilizer subsidy plays an important role in increasing the use of

fertilizer as a means of increasing the production of paddy. The government of Sri Lanka started the fertilizer subsidy in the first instance with an objective of promoting its use to ensure increased production and self-sufficiency in rice (Weerahewa *et al*., 2010). However, based on the results depicted in Model A of Table 3, it can be seen that the marginal effect of the fertilizer subsidy is quite small and of low significance (i.e., at only 10%). It means that the existence of the subsidy is of significantly less importance compared to effect of other variables such as the price of seed paddy, price of labour etc. this finding suggest that the fertilizer subsidy could be removed gradually in the long-term. Earlier attempts by the government indicate that significant reductions in the fertilizer subsidy (such as the proposed reduction of 25%) as a one-off strategy will not encourage farmers to less-use of fertilizer nor adopt organic fertilizers (Ministry of Finance and Planning, 2013). All these findings suggest that Sri Lanka can remove the fertilizer subsidy gradually.

Model B in Table 3 represents a random effects model, which was undertaken to evaluate the impact of the area dummy variable (i.e., commercial or non-commercial) in the demand for fertilizer. A positive and significant relationship was found between the area dummy variable and the demand for fertilizer, suggesting that, on average, demand for fertilizer increases by 0.10% when the paddy cultivating area is in commercial cultivation. These results are consistent with our hypothesis, that more fertilizer is demanded by commercial paddy-cultivating areas. Based on these results, we further argue that the fertilizer subsidy can be reduced by a significant amount from the non-commercial paddy-producing areas in the short-term. As explained earlier, regardless of whether it is applied to commercial or non-commercial farming, the fertilizer subsidy has played little influence on the demand for fertilizer. If fertilizer is being demanded more by commercial farmers, then it is possible to take the fertilizer subsidy away from non-commercial farmers within the next two to three years. However, in order to ensure self-sufficiency in rice and to stabilize the local prices for rice, it is important that the fertilizer subsidy be continued with the commercial farmers, at least in the short-term. It can be removed gradually from commercial farming within the next 3-5 years, taking a long-term perspective.

One important study that motivated us to look at the factors that affect the demand for fertilizer was done by Ekanayaka (2005), suggesting to remove the fertilizer subsidy since the price of fertilizer had only limited significance (i.e., at the 10% level) on the demand for fertilizer ($p < 0.093$). Ekanayaka used data for the period from 1990-2005. However, according to our panel data regression analysis (Models A and B), for the period from 1990-2011 suggest otherwise, where the impact of the price of fertilizer on the demand for fertilizer was significant at the 1% significance level ($p <$

0.000). Therefore, the same data used by Ekanayaka (2005) for the period of 1990-2005 was reanalysed using a panel data regression for comparison purposes. In contrast to the findings of Ekanayaka, our results indicate that the price of fertilizer significantly impacts the demand for fertilizer at the 1% level significance ($p < 0.000$) for the period 1990-2005. The difference between our results and those of Ekanayake (2005) may be due to the fact that Ekanayaka used national-level aggregated data and only a handful of observations (n = 24), whereas our analysis is a panel data regression based on area-level data and a much larger number of observations (n = 220). Results of this analysis are reported in Models C and D in Table 3.

Our findings suggest that, since 2005, the price of labour and cost of pest management have significantly contributed to the demand for fertilizer (comparing Models A and C). The relationship between the demand for fertilizer and the other variables, such as the price of seed paddy, paddy output and cost of materials, does not change with the addition of data from 2005-2011. However, cost of machinery negatively and significantly affected the demand for fertilizer during 1990-2005 but not beyond 2005. This suggests that farmers have been using less fertilizer with increased use of machinery. However, over the last six years (2006-2011) their demand for fertilizer appears to be more dependent on the cost of labour. This result further confirms the increasing scarcity of labour in paddy cultivation and therefore suggests mechanization as an alternative solution to address the scarcity of labour while reducing the overuse of fertilizer.

DISCUSSION

Estimated results suggest that the factors such as price of fertilizer, price of seed paddy, price of labour, quantity of paddy output, cost of materials, cost of pest management, provision of the fertilizer subsidy, and commercial paddy cultivation have a significant impact on the demand for fertilizer. The estimated function explains by 46% of the variation in the quantity of fertilizer demanded.

The price elasticity of fertilizer demand was -0.232. The cross price elasticity with respect to the price of seed paddy was -0.197 and the cross price elasticity with respect to the price of labour was 0.154. Demand for fertilizer is relatively inelastic to the price of fertilizer. This is acceptable, given the lack of close substitutes to chemical fertilizer. Organic fertilizer is practiced at a very lower level in Sri Lanka and commercial paddy farming is predominantly based on chemical fertilizers (Rodrigo, 2013). The demand for fertilizer is relatively inelastic to the price of seed paddy, which is understandable, given that seed paddy is an essential component of

cultivation. The demand for fertilizer is relatively inelastic to the price of labour given that labour is an essential cost component of paddy cultivation. The most effective way to reduce its significance is to introduce a higher degree of mechanization.

One of the major issues associated with the fertilizer subsidy is the overuse of fertilizer by farmers. Fertilizer is necessary for sustainable paddy production, but overuse will result in many negative externalities, including water pollution, damage to favourable micro and macro soil organisms, thereby reducing soil fertility, and making paddy safety-less for consumption because of cumulative chemical effects in the paddy (Gerowitt, Isselstein & Marggrat, 2003). Furthermore, as explained earlier, the fertilizer subsidy is a politically sensitive policy area in Sri Lanka (Thenuwara, 2003; Weerahewa *et al*., 2010). Therefore, there is a political economy dimension to the implementation of the fertilizer subsidy program (Ministry of Finance and Planning, 2012). Accordingly, in providing policy recommendations, we primarily focus our attention on the economic aspect of fertilizer demand. Our recommendations, based on the analyses above, are focused on three major outcomes: self-sufficiency in the production of rice; prevention of the overuse of chemical fertilizer; and the gradual removal of the fertilizer subsidy.

First, we find that the price of seed paddy has a greater impact in sustaining paddy production in Sri Lanka than the fertilizer subsidy. While increasing seed price will reduce farmers' attempts to overuse fertilizer, this might actually limit farmers' full potential to sustain production. Therefore, measures are required for the stabilization of seed paddy prices. In its budget proposal for 2014-2015, the government of Sri Lanka announced that seed paddy will be provided to farmers for free for the upcoming 'Maha' season (Ministry of Finance and Planning, 2014). This policy measure is in line with the recommendations of this study. However, we suggest that the policy measures need to be focused on at least 2-3 years (short-term), rather than a single cultivation season, as announced in the most recent budget.

Second, we recommend to reduce overuse of fertilizer, the price of labour needs to be stabilized and measures to reduce the cost of weedicides should be enacted. The policies in which encourage the farmers to increase the level of mechanization (e.g., subsidies for purchasing machinery, government-funded educational programs for farmers on mechanization, etc.), is necessary for reducing their overuse of fertilizer.

Finally, we recommend the gradual removal of subsidy in the long-term. However, a short-term reduction (within the next 2-3 years) in the fertilizer subsidy can be implemented for non-commercial paddy-producing areas,

since fertilizer usage in such areas is relatively lower. However, the small-farmer concentration is also high in non-commercial areas (Thennakoon & De Silva, 2013). Therefore, removal of the fertilizer subsidy could reduce the yield, which might impact on producers' household rice consumption and self-sufficiency. One way in which the government can reduce farmer dependency on chemical fertilizer in non-commercial areas is to encourage the use of organic fertilizer (Ghosh, 2004; Cordell, Drangert & White, 2009 & Leifeld, & Fuhrer, 2010).

The removal of the fertilizer subsidy brings about two main advantages (1) encourage farmers to adopt more organic fertilizer (2) allow the private fertilizer market to develop. Adoption of organic fertilizer will take time and will be determined by many factors. The establishment of the private fertilizer market will reduce the miss-use of fertilizer and would remove the inefficient farmers from paddy farming. Now that Sri Lanka has removed the fertilizer subsidy and introduced a voucher system, the above mentioned advantages will start taking place. However, it might take several more years for the paddy farming sector to operate with minimum support from the government and to determine the prices and the quantity of fertilizer through the market forces.

CONCLUSION

This study has explained the central importance of understanding the factors affecting to fertilizer demand in the paddy sector in Sri Lanka for the purpose of exploring the possibility to total removal of fertilizer subsidy and substitutability of chemical fertilizer from organic fertilizer. The study used the secondary panel data gathered by the Department of Agriculture and Department of Census and Statistics for the period of 1990-2011 to estimate the input demand function for paddy cultivation sector. The most obvious finding to emerge from this study is that the factors such as price of fertilizer, price of seed paddy, price of labour, quantity of paddy output, cost of materials, cost of pest management, provision of the fertilizer subsidy, and commercial paddy cultivation have a significant impact on the demand for fertilizer. The study further found that the demand for fertilizer is relatively inelastic to the price of fertilizer, price of seed paddy, and the price of labour however, the price of seed paddy has a greater impact in sustaining paddy production in Sri Lanka than the fertilizer subsidy.

In the discussion it is found two major issues: the overuse of fertilizer by farmers and the politically sensitive of the policy associated with the fertilizer subsidy.

The findings of this study suggest that Government of Sri Lanka can remove gradually fertilizer subsidy for commercial paddy sector in the long run using two strategies. First is the development of organic fertilizer industry for non-commercial paddy sector and second is adoption of competitive chemical fertilizer market for commercial paddy sector which is mostly used the chemical fertilizer.

The current findings add to a growing body of literature on practice the indigenous growth strategy in small open economy like Sri Lanka. Future research should therefore concentrate on the investigation of strategies to develop the organic fertilizer industry using new technologies, and natural and human resources endowment in the rural sector.

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Appendix A

Table 1. Results of the Hausman test for data from 1990-2011

Variable	Fixed Coefficients	Random Coefficients
Price of fertilizer	-0.232	-0.219
Price of labor	0.154	0.044
Price of seed paddy	-0.197	-0.111
Quantity of output	0.152	0.387
Cost of machinery	-0.097	-0.119
Cost of materials	0.213	0.239
Cost of pesticides	-0.064	-0.071
Subsidy dummy	0.074	0.086

The Hausman test is focused on the null hypothesis that the efficient estimates of the random effect model have no significant difference from the efficient estimates of the fixed effect model. Therefore, if the null hypothesis fails to get rejected (P value is less than 0.05), then there is no significant difference between the two approaches and a random effect model can be used. However, if the null hypotheses get rejected (P vale is less than 0.05), then the fixed effect model should be used.

Test Value: 18.95 Prob>Chi2 = 0.01

PERSPECTIVES

BASIC ELEMENTS OF BUDDHIST ECONOMICS

PERSPECTIVES

Sri Lanka Journal of
Economic Research
Volume 3 (2)
December 2015: 101-111
Sri Lanka Forum of
University Economists

SLJER

Glen Alexandrin
Beligalle Dhammajothi

Abstract

This paper attempts to show that the quantitative Buddhist Economics (BE) "can be done" with the modern techniques which are well known and available to the community in any of the society in the world. We wish to emphasize the importance of this point because we feel that it is investigation of this kind which will take BE out of the underworld of economics and make its input and important and necessary part of traditional economics. The data and information were collected from deferent sources available in Buddhist literature and discussion with key informants who practice the Buddhism. BE starts with a belief in the power of the people and in their ability to change their thought and thus their economics and their environment. This shapes the distinction draw between social science and social actions, between thought, descriptions and acts. The world is spun by the mind. Buddhism asks you to give up your ego and this life for the benefit of others and for the happiness of your future life. Buddhist saints, like all the rest of saints, did not have fun. Being with a realized being is no fun: it is being with emptiness itself. BE tries to decipher some of this: to look at this secular and religious lives simultaneously. The conclusion is – as well we know – it is possible to do that but it is not easy. BE tries to explain that and to give some guide-lines: on the demand and supply side.

Glen Alexandrin

Prof. Glen Alexandrin was formally Lecturer in Economics and Statistics at Department of Economics, College of Commerce and Finance, Villanova University and lectures on Buddhist Economics in the American Institute of Buddhist Studies in Amherst Mass. USA.

Beligalle Dhammajothi

Dr.(Rev.) B. Dhammajothi is a Senior Lecturer at Department of Palli and Buddhist Studies, University of Ruhuna, Matara, Sri Lanka

INTRODUCTION

For the purpose of this paper, we shall go along with Schumacher's definition of Buddhist Economics (BE). The title: Buddhist Economics may be seen as a proxy for a meta-economics. It deals with the connection among ethics and political economy, as so well explained by Daly (1991). Needless to say, we feel that it is a part of the job of some economists to approach the study of this "inter-disciplinary complex" from the economic end, just as some of the religious leaders, statesman, and philosophers approach this topic from the "other" end. At this point, however, it may be useful to distinguish our line of approach from the important work of Boulding (1968). After Schumacher (1973), we have often seen quoted Boulding's sentences which at the same time contain the words economics and religion. It would be a mistake, however, to conclude that he deals with the interpenetration of religious values or of ethics with economics. In Boulding's work, the causality runs from economics to the religious institutions which are viewed, much as our factories and schools of finance, as the outgrowths or the replicas as the emerge of capitalism. A product of the capitalist environment, he does not see a way out of it. The view of this paper is, in a positive sense, ideological. With this context, this paper attempts to show that the quantitative Buddhist Economics "can be done" with the modern techniques which are well known and available to the community in any of the society in the world.

Buddha[1] was no economist; he left the job to some of us, as he searched for the ultimate answers. Economics was not invented to give ultimate answers. It gives the answers to designing of the way of life, which, if pursued, leads to enlightenment. Buddhist Economics deals with the Eight – Fold path[2], the middle way, and it stresses what we all know: inseparability of *artha* and *dharma*[3], the fact that we practice Buddhism and attain what we are destined to attain this human body.

Buddha did say "prices" on several occasions; he did not say "demand", "supply". He was into the ultimate solutions; he left the footnotes on the day-to-day living in the lectures on the Eight – Fold path and two truths:

[1] A Buddha is an enlightened person who acts spontaneously for the benefit of all others, with compassion, wisdom and energy.

[2] The Eightfold path includes of right view, thought, speech, action, effort, vocation, mindfulness and concentration.

[3] The doctrine of the Buddha; it has two aspects instructions and understanding, former being what one learns latter one's internal realization.

the ultimate and the relative. He showed us several lands of bliss in which economics is irrelevant, in which our needs are satisfied and salvation guaranteed. In the Vimalakirti Sutra he taught the identity of *Sansara*[4] and *Nirvana*[5]. If you go North of Berkley to Ukiah, take the first exit and turn right you will be in the pure land built by the Venerable Master Hsuan Hua. But when we are at home, you find in your holes that it is easy to dedicate one's self to a better future life.

With all our imperfections, greed, lusts, and depression, we must choose to use this life in worthwhile ways. This is the way of the *Bodhisattva*[6], even though he looks like me, short, ugly and near-sighted and only but 2% *Bodhisattva*. BE does not deal with perfection; with rich donors; it deals with imperfections, scarcity of time and money; people stuck in dead end jobs; and the path to perfection. Why not?

The root part of BE is the individual and his motives: The precepts we take, the *paramitas*[7] we strive to achieve. From the point of an economist, these can be regarded as motives to be expressed in action, not only as a set of ethical rules. They become internalized through a practice of many lifetimes and through practice now. The educational value of Buddhism is that it tells you how to transform your motives for the benefit of other sentient begins and not for your own, as in Lam Rim Chenpo[8]. It is the unlearning of Jeremy Bentham and "me-my-I".

MAKING OF BE

We start with Milton Friedman's definition of economics into the Positive and Normative parts. BE keeps the good parts of Positive Economics and fills in the Normative part. In this presentation, Buddhism is the only content in the normative part and this is a simplification.

[4] The cycle of existence in the three realms, the desire realm, form realm and formless realm.

[5] Passed from suffering; the state of ceaseless bliss and extinction of all Fettering passions.

[6] A *Bodhisathva* is a person who has vowed to attain enlightenment for the sake of all living beings and aspires to behave in daily life as he/she was already a Buddha. His/her behaviour follows the rules of the *paramitas* and the middle way.

[7] *Paramitas*: perfection; in our case a motive an action.

[8] Lam-Rim- A Tibetan "how to become enlighten"

Suppose a recursive model of an economy is written as follows:

$$\mathbf{Y = A + BX + CV + E}$$

In which,

Y = a vector of indigenous variables;

A = a matrix of constants;

B, C = matrices of slope;

X = a vector of exogenous economic variables;

V = a vector of value variables which have a significant effect on Y; and

E = the errors of matrix

V is a value block or, as we shall refer to it, a V-block, composed of variables which are not traditionally regarded as "economic" variables. The notion of what is an "economic" variable, as we know is both subjective and impermanent. The economic variables of Ricardo and Malthus, for example, were quite different from those in Keynes' *General Theory*.

The X and Y vectors are the economic variables as measured by the important U.S. statistical agencies: investment, consumption, savings, GDP, etc. The "togetherness" of these variables we call the Materialistic Block or the M-block.

The V-block, then, can be composed of Buddhist elements -b-elements—the yet unmeasured values, mores, and feelings which influence, in complicated ways and with various strengths, the readings of the empirical values in the M-block and the variables and coefficients related to them, as well as the Y vector.

A typical embedded equation of this "Buddhist" model then can be:

$$\mathbf{Y = a + bx + cv_1 + e}$$

If, for example:

Y = a quantity of automobiles demanded;

a = a constant or intersect;

b, c = slopes;

x = income of individuals;

e = estimating error; and

$\mathbf{v_1}$ = the b-element variables patience and Mindfulness;

and if the coefficient c is significantly from zero, we can say that this is a demand curve of "Buddhist" set of individuals for automobiles. For their purchases, in this example, Patience would enter on the timing of the purchase while mindfulness would relate to the appropriate selection of the model. An effect would be a decrease in impulse buying and an increase in the need for informative advertising.

Ideally, in a Buddhist Economics, only one variable – a constant – would be needed to define the V-block: enlightenment. As enlightenment cannot be captured by "economic language", we use b-elements as the value variables. They are, then, one basis on workable normative economics can be built.

The Buddhist scriptures give us a good source of b-elements—ethical and psychological elements of human behaviour which describes an essentially Buddhist type of "personality". Because the Buddha was teaching different individuals with different endowments and aspirations, he gave his teaching in a heterogeneous way. One of these was related to appropriate conduct, another related to the *dharma* of the four truths, another corresponded to the *dharma* of twelve causes and conditions.

It is in the *Lotus Sutra* and the Maha-vyutpatti that we found the *paramitas* which related directly to ordinary persons trying to follow the Buddhist path towards enlightenment. From these works, and from discussions of meditation instructions and their experiences, we have derived our b-elements.

The *paramitas* are defined in the Buddhist Sanskrit literature as follows:

1) Dana (giving, generosity, liberality);
2) Sila (perfect virtuous conduct, morality);
3) Ksanti (absolute forbearance, patience);
4) Virya (energy);
5) Dhyana (un-disturabable contemplation);
6) Prajna (wisdom)

These are six chief *paramitas.* The four supplementary *paramitas* are:

7) Upaya or upaya – kaucalya (skilfulness in the choice or adaption of means for conversion or succour);
8) Pranidhana (aspiration or intention)
9) Bala (strength, power); and
10) Gnana (knowledge)

These last four *paramitas* can also roughly be expressed (in order) as skilful means, conviction, self-reliance and education.

From our point of view, the *paramitas* or "six perfections" may be regarded as the externally given normative rules of conduct which an aspiring Buddhist, or a *bodhisattva*, or a person the Buddhist path, over a period of years, will attempt to internalize. A brief summary of this discussion is given in table 1.

Table 1, b – Elements and Behavioural Expressions of Economic Assumptions

Aspect	Traditional Economics M – BLOCK	Buddhist Economics V - BLOCK
Type of person	"Economic Man" of Adam Smith	A Buddha A Bodhisattva
Operators	Rationality Maximization Minimization Optimization	Rationality Middle - Way Co – determination Optimization Indeterminacy
Variables	Utility, Profit Costs, Consumption, Investment, Unemployment, Rate of Utilization, Productivities	Perseverance Generosity Patience Compassion Impartiality Perspective Mindfulness
View of the World	One point in time and Space -- Euclidian	Impermanence… Multiple universes and Three Buddhas past, present and future
Behavioural force	Competition	Cooperation

Here are some examples:

ONE

A Buddhist firm would not single minded set out to maximize short run profit, or sales volume at the expense of a labour force or its competitors, trying to squeeze the most out of its capital investment. Alternative solutions exist. By incorporating the b-elements – particularly Generosity and Perspective – in its search for a path between extremes and looking forward to cooperation, retaining, and changes in work-hours to enhance the productivity of its workers the firm can prosper. Similar approaches are a part of the "Japanese" system of management. Many of the new stated efforts of the U.S. Department of labour in 1994 follow similar lines of thought.

TWO

Buddhist economics addresses the problem of exhausted resources and scare supply. Before being confronted by real or imagined shortages, or rising prices, the Buddhist Economist would say "drop your demands". This is one of the economic meanings of the b-element Generosity – do with less so that others may have more. It hits the demand side. The Buddhist Economist would say that by using the b-elements we can create the best future that can be conceived at this time; the pursuit of the *paramitas* in all walks of life, and at all times, is a good rule that leads to the benefit of all in the long run.

Schumacher's idea of appropriate technology illustrates the application of "skilful means" on the supply side. Capital equipment must be appropriate or, failing that, "small", with a high labour/capital ratio. This is appropriate to the total environment. Buddhist Economics also places emphasis on vigorous learning and the application of that learning: on all inventions.

It would be naïve to think that strategies, tactics, and techniques for social change will arise naturally out of love and compassion. They need be love or compassion motivated, but right action needs support and expertise, which Buddhists call wisdom, and an energy drive.

THREE

In 1991 I showed that one can buy cheese and socks and enlightenment, at the same time, in the market place. In this I followed Gary Becker's theory of consumer behaviour, introduced a new good -- "enlightenment" – in addition to 'one commodity' such as food, had six income constraints and four time constraints, did Lagrangean

multipliers, followed Kramer's rule, and used the Jacobians. One result was a price solution both for 'food' and 'enlightenment'. A second result was that the desire for more satisfaction from the "enlightenment" good leads to a "corner solution" in goods choice. In other words, the Buddhist practitioner cuts down on his work time, perhaps income, on consumption expenditures, and practice more.

The conclusion, in other words, is that the solution confirms what we all feel -- that the pursuit of enlightenment is costly.

SPECULATIONS IN MACROECONOMICS

Beyond what many others with a good heart say on the topic of policy, I have little to add. On the whole, one can't go wrong in policy design if one is well intentioned, other – oriented, wise, and ethical and has a team of professionally competent economists. The overlap of Buddhism and Economics, however, provides a Bateson "depth of field". I have, thus, three main points. First, economic policy – making is a highly technical field (like building an ocean liner); it has many buttons to push. What we need, therefore, is young people trained in Economics, ethics and, if you wish, social/cultural anthropology. Two, the conduct of a Buddhist Economic policy could pursue many objectives: full employment, education and so on. But it would be costly in dollar terms, it would lower per – capita disposable income, and step on many egos. In preparation for that, citizens should learn to demand tax hikes and accept bigger deficits. If we are prepared for this type of re-training, we are on a way to thinking the policy uses of Buddhist Economics. This is a test. Three simple policies, like consumption and user taxes and subsidies can work and be legislated first. Individual practices are tools for transforming one's mind and energy and applying it to one's environment. In the U.S. President Clinton's increases on gasoline, liquor and increased progressivity of the whole tax system are some of the examples. The urgings to reduce borrowing by consumers and to raise savings, and investment in industries, and in labour, by President Bush, and, then Clinton, are further examples of "going green", something that even *Shariputra* would agree on.

What would be the "policy ends" of a Buddhist Economics? For consumers, their individual policy would include finding a useful job, curtailing consumption, spending more time and resources on religious practices becoming dedicated to being an energetic and mindful

member of society. In short, one would attempt to "act locally and think globally", to benefit self, others and future generations.

For producers, the path of the middle way would provide the guide to finding ways of also helping individuals and society. Industries including the government would produce socially useful goods and services to satisfy the needs rather than desires, decreasing the production of those goods which are unnecessary or harmful. Among their ends would be reasonable profits and appropriate hi-sci-technology.

SOME DIAGNISTICS AND RED FLAGS

1. In the U.S. Buddhism may be middle class and yuppie. No massive Buddhist movement is on the horizon. BE, therefore, is a tool for thought only. As you know, even after a Constitutional Change, it takes some 50 years to reach a new equilibrium.

2. BE – on the personal level – asks the individual to do more and get less: to give up the narcissism of the known "me, my, I". This rubs us the wrong way. Buddhism in the future, in America, like our education, entertainment and religion industries, may become more consumer driven, more 'feel good' - product oriented.

3. The legislature in both of our countries is into privatization and downsizing. HHDL14, several decades ago, and Agvam Dorziev in the 1920's, felt that Buddhism, although a – political, is more Socialism compatible.

4. Doing Buddhism on the cushion and in the market place, is good for our *Karma*, our future lives; it makes us better people now.

5. This (4) above, minimally, contributes to sustainability and environmental quality in a voluntary way. It is workable even in the most of the Republican regimes.

6. The (5) above may have an aesthetic by-product: we shall see the world as more beautiful and make it so.

SUGGESTIONS FOR FURTHER WORK

1) It is a thought to have a discussion, once a year, in the *sangha* on the topic of money management, economics. It is it would be essential to distinguish the good natured advice, as la Benjamin Frankling, from Economics. Without a proper perspective on the latter, it would be hard to make proper decisions in the future; this is what we say in our introductory courses.

2) The relating of our sitting to the market place is not out of question. I know of monks who have no dental or medical insurance and have bad gum problems.

   But this step has to originate with our Western Economics, and, Political Science, if you wish. There is no need start from zero; it was the West which discovered and refined Economics as a science. The fact that it has been based on the specific, island – type set of assumptions is a historical fact; also, these assumptions in turn have received re-definitions in the hands of the Chicago school and of the Economic Reports of the President of the 1980's. But, again, so did Amartya Sen. It need to be stressed that the science of managing of the economy or of one's own lifetime budget is sophisticated.

CONCLUSION

Objective of this paper has been to discuss some basic elements of Buddhist Economics, with a view of relating them to traditional economics, to the mutual development of both. The objective of this paper is not advocate anything- the creation of a "just society," an appeal for write or wrong, a return to "early ideals"- but it is to attempt to illustrate the possibility and even the necessity of the inclusion of values in economic discussions and resulting decisions.

Our language, our tools, our methods, and solutions-bringing techniques define the problems we wish to attack in real and in intellectual life. This is as true of other areas as of economics. Economics, however, is in a "fortunate' position; it is both a theory and a technique with a reality check imposed upon it.

Buddhism, as other philosophies and religions, also has a concept of the ideal. The Buddhist notion or definition of the ideal starts internally – as

small point deep within a person's heart- and "many lifetimes" are to be devoted to the reaching of that ideal. In contrast, the Western notion of the ideal is often more external, material, corporeal, and instantaneous.

In this paper, in our discussion of "ideal" motives and values, we have illustrated hoe the pursuit of "transcendental" goals can act as both a motive and an incentive to economic activity. In our time, the pursuit of an ethical motive may very well be less zealous than the pursuit of those two "materialistic" motives of profits and utility; but historical experience seems to suggest that prices and quantities can be formed, decisions are made, and trade can take place even in the absent of these latter concepts.

We believe that Buddhist decision making would lead to a more satisfactory performance of the economic system. Economic systems fail, in the final analysis, not just because they cannot generate enough bread or wheat (or can generate too much), but because they either tame the minds of men too much.

Economics was meant to be both ethical and useful. It must speak the language of the users. A Buddhist economics might help us to work with current and future situations and could reflect the concerns of an ever-growing number of the world's population.

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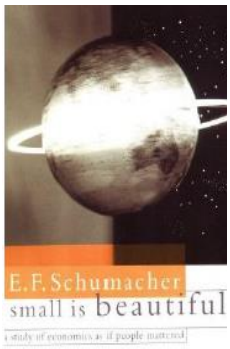
BOOK REVIEW



***Written by E.F. Schumacher**

Small is Beautiful – A Study of Economics as if People Mattered

Vintage Books, London (1993)
272 Pages, Price: UK £6.99
SBN: 0-09-922561-1

BOOK REVIEW
Sri Lanka Journal of Economic Research
Volume 3 (2)
December 2015: 115-120
Sri Lanka Forum of University Economists

SLJER

D.I.J. Samaranayake
Department of Economics and Statistics
University of Peradeniya, Sri Lanka
Telephone: 071-2919780
Email: janaranjanasamaranayake@gmail.com

INTRODUCTION

Completion among social disciplines and scientific methodology has been captured in all socio-economic dynamics into one particular parcel which introduce as the 'mainstream' of contemporary academia. This has been raptured all academics who deals within a comfort zone while facilitating more objective approaches. In economics also this is a popular subject matter which organizes its path coherent to more objectified method exclusive from other disciplines. It relays under number of assumptions and less generalized conclusions. Therefore, number of academics tends to question and criticize those fundamentals of mainstream economic modules. Ernst Friedrich Schumacher is one of that innovative "anti-objectify" economists and philosophers who contribute to sustain the argument: "studying economics is only one outlet of knowledge and it needs assistance of other social disciplines to be more progressive and to address the natural phenomenon". Therefore, his academic writings address more subjective approaches with the essence of spirituality and philosophy of modern thinking.

Schumacher, a British economist was a worldwide influential economic thinker with a professional background in statistics too. *Small is Beautiful* is a collection of essays written and compiled by him under four major parts namely, "The Modern World", "Resources", "The Third World" and "Organization and Ownership". All these parts are split into smaller components, which are linked to each other, but are strongly influenced by different lecture notes, articles and quotations.

In advance, this book basically questions many assumptions used in mainstream economics and highlights some popular delusions. It was first published in 1973 by Blond & Briggs Ltd, London during the time United Kingdom entered into European Economic Community. Also it became a one of the ground breaking publication during the period of energy crisis (around 1973). Then it was published again by Vintage publishers in 1993. This edition includes an attractive introduction by Jonathon Porritt as an edition to the previous edition. The edition in 1993 will be review in this paper. Moreover, it is known as one of the most influential 100 books published since World War II and is regarded as an influential by modern intellectuals. Therefore, it is worth writing a book review on this publication which argues against excessive materialism and meaningless growth with very useful subjective approach for modern thinking in economics.

ORGANIZATION OF CHAPTERS

As already mentioned, this book consists of four major parts (Chapters). The first part "The Modern World" was split into five sub-parts namely, a) The Problem of Production, b) Pease and Permanence, c) The Role of Economics, d) Buddhist Economics and e) A Question of Size. This part basically questions the myths and fallacy ideologies that occur through more objectify analysis regarding complex human choice and actions. Therefore, the part provides strong arguments against economists who often mislead true nature of environment and economy.

For an example, the author highlights that either capitalists or socialist ideology has failed to clearly recognize margins of the nature and human begins. Since mankind is aiming unlimited growth with limited resources from the environment, problem of production may occur. People fail to use adequate measures to identify true costs that can occur which we do not include in cost calculations on what nature provide. Therefore, Growth of National Product will not be the accurate and suitable way to measure human substance. Moreover, the author discusses about the belief that 'Rapid Economic Growth is a way into a brighter future'. According to

Schumacher, people may be more peaceful and happier if they are rich and can consume more. Here he has mentioned about a universal prosperity and happiness which will become true along with three hypotheses (1) It is possible to achieve universal prosperity (2) This achievement is possible with the basis of 'enriching your selves'. (3) It is the way to peace. Then some remarkable comments through the third and fourth sub parts reveal how economics should be modified to accommodate local needs, beliefs and specialties. Finally, he questioned the common belief at the time; 'The big is better'. His argument provides very important facts to think twice about the large scale technology as the root of degrading human beings and environment.

The second part of this book "Resources" was split again into five sub-parts namely, 'The Greatest Resource – Education', 'The Proper use of Land', 'Resources for Industry', 'Nuclear Energy – Salvation or Damnation' and 'Technology with a Human Face'.

Schumacher starts this part while emphasizing the importance of education as the most vital resource of all. The key factor of all economic development comes out of human mind. However, the author lets readers to think twice about the knowledge and mind. Education is all about gaining knowledge. But the nature of knowledge may depend upon the influence of fixed ideas in our mind to the learning system. Moreover, Schumacher demonstrates how mankind split into two different roles; the consumer and producer. Then he uses the agricultural sector and proper land usage as evidence to demonstrate that how people generate negative consequences on themselves without compromising the above two roles under the basis of profit seeking behaviour? At the final phase of the second part Schumacher investigates the applicability of nuclear energy as an energy source for the future world and also to the environment. As in his projections, economic prosperity of the world seems to be linked with nuclear energy (Which is a vigorous energy source recently) but with critical environmental issues with non-destroyable radioactive waste. In addition to that, the fifth sub-part provides some arguable comments on the use of technology. According to him, technology should respond to actual needs of people and it should enable people to use their creativity along with local necessities.

The third part of this book "The Third World" was split into four sub-parts namely, 'Development', 'Social and Economic Problems Calling for the Development of Intermediate Technology', 'Two Million Villages' and 'The Problem of Unemployment in India'. This part basically uses the practices from under developed countries as a proxy to investigate the role of intermediate technology for the development of under-developed economies. Schumacher argues that the 'trickle-down theory' may not improve the level of employment of people in an equal manner. It will

usually increase the per capita net income for people in urban areas but not the ones living in rural areas. As the author mentions the industrial mode of production is not a sustainable application for an economy since it obstructs the availability of natural resources as well as the quality of nature. Moreover, he has mentioned that the problem of production may not be solved through a changing approach from capitalist to socialist because this issue may not occur as a result of either capitalist or socialist class structure. On the other hand, he identifies the Indian unemployment issue as an evidence to strengthen his arguments and confront the Western technology. Massive rural to urban migration and the lack of infrastructure for such technology may create adverse effects on India through these Western applications. Therefore, Schumacher believes that instead of capital incentive technology, inexpensive small-scale labour incentive technology may improve economic conditions of rural India.

The fourth and final part of this book "Organization and Ownership" was split into five sub-parts a) A Machine to Foretell the Future, b) Towards a Theory of Large-Scale Organization, c) Socialism' and 'Ownership' and d) New Patterns of Ownership'. This part was written by Schumacher to distinguish the ownership dimensions, especially about public and private ownership in terms of economic development. He revisits the logic of profitability and highlighted that publicly owned capital should not estimate under the profit seeking strategies. Moreover, he suggests private ownership is best to use with small-scale enterprises. When the size of the enterprise is large it may create issues on the private ownership. Therefore, large scale organization management should adapt with proper and suitable framework to make the ownership a success.

SIGNIFICANCE OF THE CONTENT

This book is a remarkable attempt by Schumacher to address very common but vital questions occurs in different economies. It explains very complex economic matters in a simple way to understand the content of the book even though the reader should not be an economist. This simplicity as well as the depth of contemporary issues and arguments made this book an influential collection of essays at the time.

Schumacher argued about the myth of mainstream economic approaches which are more orthodox and objectify in their analytical basis. In his writings, unlike pure sciences, economics is concerned with complex human choice and actions. Therefore, economists who relied upon objective approaches may often be misled and failed to capture true behaviour of human beings. He criticizes not only the capitalist orthodoxy economists

but also the socialist. Capitalist as well as socialist causes number of failures throughout the process of reasoning for the problem of production, extremely rare capital, use of technology and ownerships. In addition to that, his intellectual critiques compound with moral states over some facts of Keynesian economic theory which is remarkable.

Schumacher appears to be a much more radical writer compared to Keynes. For an example, Keynes identifies production as a necessary requirement because it gave us material prosperity and employment and would bring us to the point where good life could be enjoyed. But Schumacher raises his ideas to confront this belief and highlights adverse effects which can occur through industrialization to the environment as well to the human beings. His ideas and critiques persuade through experience from travels to Burma; a nation compiled with Buddhist culture with more moral and psychological applications. Moreover, his ideology of small-scale technology while criticizing a dominant concept where "larger the scale will larger the returns of production" create new trend among radical economic thinkers. Therefore, *Small is Beautiful* has become more influential publication which compiled with attractive arguments persuade through the strength of Schumacher's evolution of critiques.

Roots of Buddhist Economics were nourished through Schumacher's intention to promote more subjective economic analysis. Western economic beliefs and policies attempt to maximize the consumption by optimize effort and scale of production. This perspective was redefined in Buddhist Economics as maximize the satisfaction by optimize effort and scale of consumption. Moreover, in Buddhist Economics, providing labour is essential for happiness and development of each person but not to enlarge the scale of production. In addition to that there are number of applications which are comes through Buddhist philosophy to stream of economics from this book such as intermediate path for technology and new thinking pattern for human beings apart from offer values of greed and profitability.

Another remarkable feature in this book is the quality and strength of the predictions regarding various matters. Schumacher predict the future through mixing up certainties and uncertainties while demonstrating the applicability of this publication for pathfinders in future. For an example, at the second sub-part - "The Modern World"-, he predicts the size of population, fuel consumption and fuel consumption per head for the initial stages of 21st century. Furthermore, it includes separate prediction for two dimensions, rich and poor. Predicted size of the population in the world is 6.9 billion. This figure has been overcome today in the real world. Not only have these statistical predictions, conceptual predictions also become more success, for an example use of small scale technology benefited both

environment and mankind within recent practices. This feature was embarked by Jonathon Porritt in his introduction of this publication.

"*Small is Beautiful! That deceptively simple notion still resonates very powerfully throughout the Green Movement today, reminding us all of the wonderfully inspirational life and work of one of the great figures of the modern age*." - Jonathon Porritt (pp. X)

CONCLUSION

Schumacher is an economist who strongly believes in the picture of reality to read the complex human behaviour. His attempt to build a concrete argument against the conventional mainstream approaches of knowledge has pioneered by this influential collection of essays. This reminds the economists how resources, environment and human begin can be ruined through fallacy, beliefs and values in academia. Schumacher entered to his writings by investigating weaknesses of Western beliefs of economic well-being trough production. As he mentioned, Western beliefs push economies towards a growth paradigm. Way to generate wealth is unsustainable. Inefficiencies and social breakdowns can occur with irrational economic measures. Big is not always better and local small-scale production leads to the best social and environmental outcome.

Moreover, this book exposed the strength of moral and philosophical essence in subjective knowledge by promoting Buddhist Economics approach in economic analysis. Applicability of intermediate technology with lessons from underdeveloped countries and validity of labour to make peoples' life better and happy are also other key arguments emerge. Small-scale technology with a suitable framework of ownership to serve human beings was better than large scale technology at the service of economic growth.

It is worthy to note that reader may find greater part of issues discussed in this book is related with contemporary issues in modern world. But if he looks at the year when it first came out, reader would be surprised that this book was first published in 1973. Because those issues discussed in this book are still pretty much relevant and applicable as of today. Therefore, *Small Is Beautiful* can identify as one of gigantic movement in field of moral applications in economics and subjective approaches of knowledge at the second half of the 20th century.

SLJER

The International Journal Published by the Sri Lanka Forum of University Economists

The Sri Lanka Journal of Economic Research

Editorial Office-2015

The Department of Economics,
University of Ruhuna, Matara,
Sri Lanka.
Telephone: + 94 041 22 22681/
Ext.3202
Web: www.slfue.org
Email: uh2014slfue@gmail.com

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.

The authors assume the responsibility of the accuracy of contents in their respective articles, and neither the SLFUE, nor the Editorial Board of the SLJER will bear any responsibility in this regard.

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References

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