Effects of Demographic Variables Do Indeed Matter On Demand Patterns of Pacific Island Households

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ABSTRACT

Consumer demand systems are estimated based on household expenditure micro-data and price variabilities (tapped over quarters and regions) of a developing Pacific island country. More purposefully, ‘hierarchically ordered’ modifications of parameter variations across differing demographic profiles of the households are surveyed, estimated and compared. The analysis shows that the specification that allows all its parameters to capture the demographic variabilities does exhibit the most superior explanatory econometric properties; thus implying that demographic characteristics do interact and influence household consumption behaviour. On the basis of the identifies best specification, the study empirically stylises household behavioural patterns. Moreover on the basis of its sound theoretical underpinning and procured strong empirical evidence, the study reveals that the choice of a particular manner by which effects of demographic variables are allowed to bear on an analysis of consumption behaviour does matter. Additionally, it strongly warns against ignoring such effects in analyzing patterns of consumer demand in developing Pacific island countries.

JEL Classification: C01, C18, D01, D11

Keywords: Linear Expenditure system, Quadratic Expenditure system, Consumer demand function
1. Introduction

Consumption expenditure is the largest item in the net outputs (GDPs) of the Pacific island nations. Yet there is no empirical evidence that pin-points, via conceptually meaningful behavioural parameters, the principal determinants of consumption demands in these island economies. Of particular significance – propelled by recent resurgence of interest and debate on the ‘exact’ nature of the population-economic growth relationship – is the lack of objective, theoretically sound and informative insights into the substantive effects (if any) of variabilities in household demographic characteristics on household expenditure patterns. This shortcoming must be disconcerting to those policymakers who are well aware of the several areas of the development problems to which, analyses of household demand patterns and their links to differing household demographic profiles can provide positive empirical understanding.

This study aims at providing an important contribution toward the filing-in of important gaps. In particular, it attempts, on the basis of a sound conceptual framework, to characterize alternative specifications for capturing stylisable influences of demographic variables on household demand behaviour. Moreover, it puts the implied underlying hypotheses into a specially designed form of empirical testing. The relevant empirical material is taken from Tonga – one of the developing island nations of the Pacific. This empirical material is represented by a set of micro-data that despite its essentially cross-sectional nature contains price measures – tapped from both spatial and inter-temporal sources with significant variabilities.

In terms of explicit conceptualisation, the approach taken is akin to an ‘ordered’ survey of the treatment of demographic variables in consumer demand analysis under the complete consumer demand functions framework. It addresses, inter alia, alternative means of specifying the *modus operandi* by which demographic variables enter the original demand system. By viewing, for instance these alternative means as alternative ways of allowing for variations in demand parameters to capture the differences among household demographic profiles, certain specifications become interpretable as equivalent to the original demand system but involving demographically scaled prices, demographically scaled quantities, and/or some fixed-cost parametrisations.
In order to secure a sound interpretive content, this study roots its formal working hypotheses on the demand theory of a utility maximizing consumer. As is well known, the durability of this particular approach lies in the conceptually consistent conclusions – general and particular restrictions – inherent in the demand functions that can be derived from it coupled with the highly serviceable role of utilizing these restrictions in the estimation of such demand functions.

One of the key foci of this study is on alternative methods of incorporating demographic variables that insure that the consequently modified consumer demand systems continues to inherit the theoretical plausibility that characterizes the parent demand system. In fact, this investigation shows that it does matter significantly to the analysis which particular method of treating demographic variables that is adopted. Moreover, it indicates clearly that demographic variables interact in somewhat complex ways – thus implicating the need to favour specifications rich in parameters and/or the procedure that allows the maximum number of demand parameters to depend on the impacts of demographic variables.

In the context of developing Pacific island countries, this study is the first of its kind in many respects. It is in fact the first: to adopt the “theoretical plausibility” (utility maximizing hypothesis) approach; to frame the ‘revealed’ consumer demand functions within the “complete demand system” framework; to take into account in demand analysis effects of the demographic characteristics of consumers: to address the modus operandi involved in incorporating observed variabilities in demographic variables within the complete demand system framework; to compare alternative ways of incorporating demographic variables in consumer demand analysis; to estimate econometrically and test demand parameters after subjecting them to the full brunt of the budget constraint and to carry this out econometrically within the “Seeming Unrelated Regression” set-up; and to provide demand parameter estimates and consumption behaviour-based statistics that are theoretically grounded – thus, making available estimates and statistics that have clear economic meanings and are readily literate as inputs to economic policy formulation and analysis.

This paper consists of five sections. Section 2 deliberates on specification of consumer demand function. The estimation of parameters are dealt with in Section 3; and Section 4 presents and discusses the empirical results. Section 5 offers some concluding implications of the significance
of the “demographic variables-demand behaviour” relationship on the realities of consumption behavior in developing Pacific island countries.


In this study two variants are considered to represent the original consumer demand system

\[ q_i = h_i'(P, \mu), i = 1, ..., n; \]

Where \( \mu \) is total expenditure, \( P = (p_1, ..., p_n)' \) is an \((n - 1)\) vector of goods prices. Assume that (1) is theoretically plausible and denote its corresponding indirect utility and direct utility functions by \( \psi(P, \mu) \) and \( \Phi(q) \), respectively

The first system is the familiar “Linear Expenditure System“, which exhibits linearity in the relations between quantities demanded and total-expenditure. The second system is the “Quadratic Expenditure System”, which accommodates curvature by admitting regular relations of a quadratic nature between quantities demanded and total-expenditure (Howe, 1974).

2.1 The Linear Expenditure Systems (LES)\(^1\)

By Nominating stone’s (1954) Linear Expenditure System (LES) as the original consumer demand Systems, (1) can be specified as:

\[ q_i = h_i(P, \mu) = \tau_i + \beta_i p_i^{-1} \left( u - \sum_{j=1}^{n} p_j \tau_j \right), i = 1, ..., n, \]

Where \( \mu \) is total expenditure,

In expenditure form, (2) becomes:

\[ p_i q_i = p_i h_i(P, \mu) = p_i \tau_i + \beta_i \left( u - \sum_{j=1}^{n} p_j \tau_j \right), i = 1, ..., n, \]

Both (2) and (3) Satisfy the restriction \( \sum_{j=1}^{n} \beta_j = 1 \)

\(^1\) For details see Goldberger
As can be easily deducted, with respect to good i, \( \beta_i \) is the marginal budget share, and, \( p_i \tau_i \) and 
\[
\left( \mu - \sum_{j=1}^{n} p_j \tau_j \right)
\]
may be interpreted as “subsistence expenditure” (or “committed expenditure”) and “supernumerary total-expenditure,” respectively.

### 2.2 The Quadratic Expenditure Systems (QES)\(^2\)

By nominating the Howe, Pollak, and Wales’ (1979) quadratic Expenditure System (QES) as the original consumer demand system, (1) can be specified as:

\[
(4) \quad q_i h_i(P,u) = \tau_i + \left( \frac{\beta_i}{p_i} \right) \left( \mu - \sum_{j=1}^{n} p_j \tau_j \right) + \left[ \frac{(\alpha_i - \beta_i)}{p_i} \right] \Omega \prod_{j=1}^{n} p_j^{-\alpha_i} \left( \mu - \sum_{k=1}^{n} p_k \tau_k \right)^2, i = 1, \ldots, n;
\]

In expenditure form 4 becomes:

\[
(5) \quad p_i q_i = p_i h_i(P,\mu) = p_i \tau_i + \beta_i \left( \mu - \sum_{j=1}^{n} p_j \tau_j \right) + (\alpha_i - \beta_i) \Omega \prod_{j=1}^{n} p_j^{-\alpha_i} \left( \mu - \sum_{k=1}^{n} p_k \tau_k \right)^2, i = 1, \ldots, n;
\]

Both (4) and (5) Satisfy the restriction \( \sum_{j=1}^{n} \beta_j = 1 \) and \( \sum_{j=1}^{n} \alpha_j = 1 \)

The \( p_i \gamma_i \)'s may be interpreted as “subsistence expenditure”, and notice that

\[
\left[ \mu - \sum_{j=1}^{n} p_j \tau_j \right] > 0 \quad \text{(i.e., the “supernumerary total-expenditure” must be positive)}.
\]

Further notice that QES [with (3n-1) parameters] reduces to the LES [with (2n-1) parameters] when \( (\alpha_i - \beta_i) = 0 \) for all \( i = 1, \ldots, n \), or \( \Omega = 0 \). In fact, as point out by Howe, Pollak and Wales (1979), the QES includes well-behaved non-trivial generalizations of the LES. If the \( \beta_i \)'s and \( \tau_i \)'s are such that the associated LES is “well-behaved”, then the corresponding QES is well-behaved for values of the \( \alpha_i \)'s sufficiently close to the corresponding \( \beta_i \)'s.

\(^2\) For detail characteristics see Howe (1974)
The inclusive adoption of QES – which is readily reducible to LES – means, *inter alia*, that this study is having access to a more flexible functional form, and that more complex (utility cum market based demand) behaviors could be put into some sound form of empirical testing.

### 2.3. Demographically modified systems of complete consumer demand functions.

Given that LES and QES are the variants of the original consumer demand system (1), the corresponding demographically modified systems consequent of the applications of the Explicit Correction Method specifications could be straightforwardly derived. This study refers to these demographically modified variants together with the corresponding ones under the Implicit Correction specification, as DLES (Demographicised LES) and DQES (Demographicised QES) Variants.

Under DLES, the scaling, Translating, Gorman, and Reserve Gorman specifications give identical estimating equations. This, apart from the Implicit Correction Specification, one only needs to specify two distinct DLES variants of the Explicit Correction Method.

The LES (3) in its budget share form is:

\[
\omega_i = \left( \frac{p_i}{\mu} \right) \tau_i + \beta_i \left[ 1 - \sum_{k=1}^{n} \left( \frac{p_k}{\mu} \right) \tau_k \right], i = 1, \ldots, n; \text{ Satisfying the restriction } \sum_{i=1}^{n} \beta_i = 1
\]

### 3.0 ‘Optimum’ Forms and redefinitions of parameters

The DLES and DQES variants that have been specified involve conditional equivalence scale function (the \(d,s, m’s \text{ and } s’s\)) that are linear functions of the demographic variables, \(\Gamma_1, \ldots, \Gamma_F\). In fact, the ‘optimum’ forms for these conditional equivalence scale functions are largely a matter to be determined empirically.

The choice of the form of the original demand system is also of paramount importance. Using, for instance, QES as the original demand system means that the scaling functions (the m’s) of the relevant DQES variants (scaling, Gorman, and Reverse Gorman) need to be positive. Thus, if a linear specification is earmarked for the scaling functions, it necessarily needs to be positive. An available alternative is to specify the scaling functions to be an exponential form of the demographic variables- i.e., to be the form.
(14) \[ m_i = \prod_{j=1}^{F} \Gamma^{ij} j, i = 1, \ldots, n. \]

Under the DLES variants, the redefinitions of the parameters of (the original) LES are as follows:

1. Scaling/Translating/Gorman/Reverse Gorman:

\[ \tau_i^* = \tau_i + d_i, i = 1, \ldots, n \]

2. Modified Prais-Houthakker:

\[ \tau_i^* = \tau_i m_i, i = 1, \ldots, n; \text{and} \beta_i^* = \beta_i m_i, i = 1, \ldots, n. \]

Under the DQES variants, the redefinitions of the parameters of (the original) QES are as follows:

1. Scaling: \[ \tau_i^* = \tau_i m_i, i = 1, \ldots, n; \text{and} \Omega^* = \Omega \prod_{k=1}^{n} m_k^{-a_k} \]

2. Translating: \[ \tau_i^* = \tau_i d_i, i = 1, \ldots, n \]

3: Gorman: \[ \tau_i^* = d_i + \tau_i m_i, i = 1, \ldots, n; \text{and} \Omega^* = \Omega \prod_{k=1}^{n} m_k^{-a_k} \]

4: Reserve Gorman: \[ \tau_i^* = m_i (\tau_i + d_i), i = 1, \ldots, n; \text{and} \Omega^* = \Omega \prod_{k=1}^{n} m_k^{-a_k} \]

Thus, it is legitimate to interpret these (Explicit Correction Method) specifications as ways of allowing for parameter variations among household demographic profiles. And as earlier indicated, translating parameters (the d,’s) and scaling parameters (the m,’s) may be further interpreted as committed (or subsistence) parameters and household equivalence scales respectively.
3.0 Data and empirical counterparts of variables

The empirical component of this study utilizes Tongan data set. The Tongan Data is a set of micro-data – a household unit record data set. Its coverage is clearly delineated with respect to at least, two important respects: (1) to 709 households (roughly 6.3 per cent of the 1984 population of households) in Tongatapu – the main island (with two principal regions viz. Vahekolo and Vahe’uta) of Tonga, and (2) to consumption goods acquired via market transactions only – that is, non-market goods are not covered.

The expenditures that were incurred by members of the sample households – allowing for the whole nondurable goods regimen and all four quarters of 1984 – have been appropriately aggregated into for brood consumption categories – viz., “domestic foods,” “imported food,” “non-food,” and “services” Moreover, appropriate price indexes for these consumption categories based on average prices and condorances of selected (concomitant) goods at particular space X time (i.e., region x quarter) Loci, have been computed.

Facilitated within the coverage of HIES and consequently having found their way into the Tongan Data, are 16 accessible demographic variables. The associated empirical counterparts of these variables are statistical demarcations of household profiles based on members’ age,” sex,” and occupational status” as well as household’s “size” and “(regional) location’.

HIES was based on a stratified systematic simple random sampling (SSRS) statistical model. Thus, it is argued that any ‘non-randomized’ impact of the associated designed effect is likely to be insignificant, if not nil as well as measurement error may be insignificant.

Our primary goal is to incorporate demographic effect under alternative specification of consumer demand.

4.0 Empirical results and discussions

The following empirical results yielding from utilizing the Tongan data in applications of the alternative models for treating demographic variables in demand pattern analysis may shed lights on the threshold questions put forward.

Tables 2(a) and 2(b) provide relevant likelihood values for comparing, say, the Naïve specification and other specifications that incorporate demographic effects in alternative ways.
Table 2(a) Log Likelihood Values for alternative methods of incorporating Demographic variables under LES

<table>
<thead>
<tr>
<th>Sample Partitioning Variable(s)</th>
<th>Estimation Procedure</th>
<th>Tongatapu</th>
<th>Hahekolo</th>
<th>Vahe'uta</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Number of income earners (NIE)</td>
<td>Number of income earners (NIE)</td>
<td>Number of income earners (NIE)</td>
</tr>
<tr>
<td>1. Location of Household Region</td>
<td>1. Naive</td>
<td>Total 13.470 (7)</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2. Translating Scaling/ Gorman/ Reverse Gorman</td>
<td>1362.0 (11)</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>3. Modified Paris- Houthakker</td>
<td>1356.6 (11)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Implicit Correction</td>
<td>1396.0 (14) 570.0 (7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Location of Household Region</td>
<td>1. Naive</td>
<td>1369.0 (14) 570.0 (7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Translating/ scaling/ Gorman/ Reverse Gorman</td>
<td>1376.1 (22) 574.4 (11)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Modified Paris- Houthakker</td>
<td>1372.8 (22) 571.2 (11)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Implicit correction^5</td>
<td>1434.3 (56) 600.1 (28) N/A^4</td>
<td>N/A^4</td>
<td>206.8 (7)</td>
</tr>
<tr>
<td></td>
<td>5. Implicit Correction^6</td>
<td>TNA^6 (70) TNA^7 (35) CAN^7 (7)</td>
<td>CAN^7 (7)</td>
<td>206.8 (7)</td>
</tr>
</tbody>
</table>

---

3 Number of parameters in the demand system (a particular DLES variant) are given in parentheses
4 “N/A” stands for “not applicable”.
5 The log likelihood in column “0 or ≥ 4” NIE is based on the sub-sample encomposing both households with primary income earners (NIE) and those with at least 4 NIE.
6 “TNA” stands for “Total not attained.”
7 “CAN” stands for “convergence Not attended.”
Table 2(a) Log Likelihood Values for alternative methods of incorporating Demographic variables under LES

<table>
<thead>
<tr>
<th>Sample Partitioning Variable(s)</th>
<th>Estimation Procedure</th>
<th>Tongatapu</th>
<th>Hahekolo</th>
<th>Vahe'uta</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Number of income earners (NIE)</td>
<td></td>
<td>Number of income earners (NIE)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1. Location of Household Region</td>
<td>Naive</td>
<td>Total</td>
<td>13,420</td>
<td>(7)</td>
</tr>
<tr>
<td></td>
<td>Translating</td>
<td>CNA</td>
<td>13,084</td>
<td>(15)</td>
</tr>
<tr>
<td></td>
<td>Scaling</td>
<td>CNA</td>
<td>13,084</td>
<td>(15)</td>
</tr>
<tr>
<td></td>
<td>Gorman</td>
<td>CNA</td>
<td>13,084</td>
<td>(15)</td>
</tr>
<tr>
<td></td>
<td>Reverse Gorman</td>
<td>CNA</td>
<td>13,084</td>
<td>(15)</td>
</tr>
<tr>
<td></td>
<td>Implicit Correction</td>
<td>TNA</td>
<td>1,391.8</td>
<td>(22)</td>
</tr>
<tr>
<td></td>
<td>Correction</td>
<td>TNA</td>
<td>1,391.8</td>
<td>(22)</td>
</tr>
<tr>
<td>II. Location of Household (REGION) and NUMBER OF INCOME EARNERS (NIE)</td>
<td>Naive</td>
<td>Total</td>
<td>13,420</td>
<td>(7)</td>
</tr>
<tr>
<td></td>
<td>Translating</td>
<td>TNA</td>
<td>13,084</td>
<td>(15)</td>
</tr>
<tr>
<td></td>
<td>Scaling</td>
<td>TNA</td>
<td>13,084</td>
<td>(15)</td>
</tr>
<tr>
<td></td>
<td>Gorman</td>
<td>TNA</td>
<td>13,084</td>
<td>(15)</td>
</tr>
<tr>
<td></td>
<td>Reverse Gorman</td>
<td>TNA</td>
<td>13,084</td>
<td>(15)</td>
</tr>
<tr>
<td></td>
<td>Implicit Correction</td>
<td>TNA</td>
<td>1,391.8</td>
<td>(22)</td>
</tr>
<tr>
<td></td>
<td>Correction</td>
<td>TNA</td>
<td>1,391.8</td>
<td>(22)</td>
</tr>
</tbody>
</table>

8 The sub-sample for each region is partitioned in a mutually exclusive and exhaustive basis among the five categories, indexed by “0”, “1”, “2”, “3”, and “≥4” NIE.
9 Number of parameters in the demand system (a particular DLES variant) are given in parentheses.
10 “N/A” stands for “not applicable”.
11 The log Likelihood in column “0 or ≥4” NIE is based on the sub-sample encompassing both households with primary income earners (NIE) and those with at least 4 NIE.
12 The sub-sample for each region is partitioned in a mutually exclusive and exhaustive basis among the five categories, indexed by “0”, “1”, “2”, “3”, and “≥4” NIE.
The appropriately computed Likelihood Ratio (LR) test statistics are reported in Tables 3(a) and 3(b). From these empirical results it is very clear that demographic variables (e.g., REGION and NIE) are significant determinants of household consumption demand in Tonga. At the first estimation stage, for instance, allowing all or some of the system parameters to depend on REGION leads to non-trivial improvements over the Naive specification. Even when the full impact of REGION has been allowed for (the second stage), the effects of NIE when all parameters are allowed to depend on it, are highly significant.

Moreover, according to the procured evidence -are conveyed through relevant Likelihood Ratio test statistics - the Implicit Correction specification represents a highly significant improvement over both Translating and Modified Prais-Houthakker specifications in the case of DLES and over Translating in the case of DQES. (Excepting the first stage under QES, the generalizations associated with all cases are significant at the 0.005 level)(see Table 3a and 3b). Thus, the Implicit Correction specification is clearly a superior specification compared with the specifications under the Explicit Correction Method, through which influences of demographic variables on consumer demand are manifested via only selected parameters of the demand system. Once the full impact of REGION has been allowed for, the conditional effects of NIE as facilitated by the Translating or Modified Paris-Houthakker specifications do not amount to significant improvement over the Naïve specification.

These stylized findings are strongly concurrent with the empirical findings of Muellbauer (1977) and Barnes and Gillingham (1984), even though these researchers have based their work on different specific demand systems and data sets. Like the findings of Muellbauer (1977) and Barnes and Gillingham (1984), this last noted empirical evidence suggests that the apparent complex manner in which household demographic variables tend to operate (as implied by the strength of the implicit correction framework) calls for the adoption of demand systems that have sufficient large numbers of parameters so that all essential elements of household consumption behavior are adequately capture.
Table 3(a) Summary statistics for incorporating Demographic variables under LES

<table>
<thead>
<tr>
<th></th>
<th>Translating/ Scaling/Gorman</th>
<th>Modified Paris</th>
<th>Implicit Correction</th>
<th>Naive</th>
</tr>
</thead>
<tbody>
<tr>
<td>REGIONAL</td>
<td>Reverse Gorman</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tongatapu</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Two regions combined): [setting $\Gamma = REGION]$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Log likelihood</td>
<td>1362.0</td>
<td>1356.6</td>
<td>1369.0</td>
<td>1347.0</td>
</tr>
<tr>
<td>2. Number of estimated Parameters</td>
<td>11</td>
<td>11</td>
<td>14</td>
<td>7</td>
</tr>
<tr>
<td>3. Number of observations</td>
<td>709</td>
<td>709</td>
<td>[304,405]</td>
<td>709</td>
</tr>
<tr>
<td>4. Ch-square$^3$</td>
<td>30.0</td>
<td>19.2</td>
<td>44.0</td>
<td>N/A</td>
</tr>
<tr>
<td>5. Chi-square$^4$</td>
<td>14.0</td>
<td>24.8</td>
<td>N/A</td>
<td>44.0</td>
</tr>
<tr>
<td>Vahekolo: [Setting $\Gamma = NIE]$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1. Log likelihood</td>
<td>574.4</td>
<td>571.2</td>
<td>600.1</td>
<td>570.0</td>
</tr>
<tr>
<td>A2. Number of estimated Parameters</td>
<td>11</td>
<td>11</td>
<td>28</td>
<td>7</td>
</tr>
<tr>
<td>A3. Number of observations</td>
<td>304</td>
<td>304</td>
<td>[116,96,52,40]$^5$</td>
<td>304</td>
</tr>
<tr>
<td>A4. Ch-square$^3$</td>
<td>8.0</td>
<td>2.4</td>
<td>60.2</td>
<td>N/A</td>
</tr>
<tr>
<td>A5. Chi-square$^4$</td>
<td>15.4</td>
<td>57.8</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Vahe’uta: [Setting $\Gamma = NIE]$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B1. Log likelihood</td>
<td>801.7</td>
<td>801.6</td>
<td>834.2</td>
<td>799.0</td>
</tr>
<tr>
<td>B2. Number of estimated Parameters</td>
<td>11</td>
<td>11</td>
<td>28</td>
<td>7</td>
</tr>
<tr>
<td>B3. Number of observations</td>
<td>405</td>
<td>405</td>
<td>[203,119,32,51]</td>
<td>405</td>
</tr>
<tr>
<td>B4. Ch-square$^3$</td>
<td>5.4</td>
<td>5.2</td>
<td>70.4</td>
<td>N/A</td>
</tr>
<tr>
<td>B5. Chi-square$^4$</td>
<td>65.0</td>
<td>65.2</td>
<td>N/A</td>
<td>70.4</td>
</tr>
</tbody>
</table>

$^1$ “N/A” stands for Not applicable

$^2$ Gives the number of observations for Vahekolo and Vahe’uta respectively.

$^3$ Calculated as minus twice the difference between the log likelihood value in the column and the corresponding log likelihood value under the Naïve procedure. (Selected critical values: $x^2_{.05/.01,3}=7.8/11.3; x^2_{.05/.01,7}=14.1/18.5$)

$^4$ Calculated as minus the difference between the log likelihood value under the implicit correction procedure and the log likelihood value in the column (selected critical values: $x^2_{.05/.01,3}=7.8/11.3; x^2_{.05/.01,7}=14.1/18.5$)

$^5$ Gives the number of observations for “1”, “2”, “3” and “0 or ≥4” NIE.
Table 3(b) Summary statistics for incorporating Demographic variables under QES

<table>
<thead>
<tr>
<th>REGIONAL Statistics(^1)</th>
<th>Translating</th>
<th>Implicit Correction</th>
<th>Naive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tongatapu (Two regions combined): [setting ( \Gamma = \text{REGION} )]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Log likelihood</td>
<td>1384.7</td>
<td>1391.8</td>
<td>1370.2</td>
</tr>
<tr>
<td>2. Number of estimated Parameters</td>
<td>15</td>
<td>22</td>
<td>11</td>
</tr>
<tr>
<td>3. Number of observations</td>
<td>709</td>
<td>[304,405](^2)</td>
<td>709</td>
</tr>
<tr>
<td>4. Ch-square(^3)</td>
<td>29.0</td>
<td>43.2</td>
<td>N/A</td>
</tr>
<tr>
<td>5. Chi-square(^4)</td>
<td>14.0</td>
<td>N/A</td>
<td>44.0</td>
</tr>
</tbody>
</table>

Vahe'uta: [Setting \( \Gamma = \text{NIE} \)]

<table>
<thead>
<tr>
<th>REGIONAL Statistics(^1)</th>
<th>Translating</th>
<th>Implicit Correction</th>
<th>Naive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tongatapu (Two regions combined): [setting ( \Gamma = \text{REGION} )]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Log likelihood</td>
<td>586.2</td>
<td>654.5</td>
<td>581.7</td>
</tr>
<tr>
<td>2. Number of estimated Parameters</td>
<td>15</td>
<td>55</td>
<td>11</td>
</tr>
<tr>
<td>3. Number of observations</td>
<td>304</td>
<td>[19,116,96,52,21](^5)</td>
<td>304</td>
</tr>
<tr>
<td>4. Ch-square(^3)</td>
<td>9.0</td>
<td>145.6</td>
<td>N/A</td>
</tr>
<tr>
<td>5. Chi-square(^4)</td>
<td>136.6</td>
<td>N/A</td>
<td>145.6</td>
</tr>
</tbody>
</table>

Vahe’uta: [Setting \( \Gamma = \text{NIE} \)]

<table>
<thead>
<tr>
<th>REGIONAL Statistics(^1)</th>
<th>Translating</th>
<th>Implicit Correction</th>
<th>Naive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tongatapu (Two regions combined): [setting ( \Gamma = \text{REGION} )]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Log likelihood</td>
<td>812.7</td>
<td>878.9</td>
<td>810.1</td>
</tr>
<tr>
<td>2. Number of estimated Parameters</td>
<td>15</td>
<td>55</td>
<td>11</td>
</tr>
<tr>
<td>3. Number of observations</td>
<td>405</td>
<td>[30,203,119,32,21]</td>
<td>405</td>
</tr>
<tr>
<td>4. Ch-square(^3)</td>
<td>5.2</td>
<td>137.6</td>
<td>N/A</td>
</tr>
<tr>
<td>5. Chi-square(^4)</td>
<td>132.4</td>
<td>N/A</td>
<td>137.6</td>
</tr>
</tbody>
</table>

\(^1\) “N/A” stands for Not applicable

\(^2\) Gives the number of observations for Vahekolou and Vahe’uta respectively.

\(^3\) Calculated as minus twice the difference between the log likelihood value in the column and the corresponding log likelihood value under the Naive procedure. (Selected critical values: \(x^2 .05/.01,7=14.1/18.5\); \(x^2 .05/.01,40=55.8/63.7\))

\(^4\) Calculated as minus the difference between the log likelihood value under the implicit correction procedure and the log likelihood value in the column (selected critical values: \(x^2 .05/.01,7=14.1/18.5\); \(x^2 .05/.01,40=55.8/63.7\))

\(^5\) Gives the number of observations for “1”, “2”, “3” and “0 or ≥4” NIE.
4.1 Demographically Corrected System parameter estimates and policy-based statistics

(a) Marginal budget share and total expenditure elasticities

Regarding estimates of average marginal budget shares and total-expenditure elasticities, the relevant result summarised in Table 4. With respect of the estimates of average marginal shares, a close similarity among the estimates associated with a given consumption category within a given region for three household types characterized by 1, 2 or 3 income earners (NIE). The said similarity is more consistent in the case of vahe’kolo as compared with the case of vahe’uto. And, in fact, the uniformity in magnitudes is striking for the case of imported food at Vahekolo and Domestic food at Vahe’uto.

Marginal budget share for the above (1, 2 and 3 NIE) household types as compared with those for the “0” NIE household type as well as with those for the “≥ 4 NIE” category are markedly different. In the case of vakekolo, but the “0 NIE” and “≥4 NIE” household types tend to display weaker marginal responses to an extra dollar of total-expenditure in terms of the demands for Domestic food, Non-food, and services. As expected, the reverse trend holds in the case of the remaining consumption category (Imported Food).

For the case of Vahe’uta, comparable trends are not evident. Apart from the “≥Nie” household type- where Non- Foods displays the largest average marginal budget share (40 percent) – all the other household types (as in all household types of Vahekolo) indicate that imported food dominates the competition for any marginal increase in the household budget. Notice that this stance is still preserved even in the case when the estimates are agnostic towards differences in household type according to NIE.

With respect of total-expenditure elasticities (Table 4), the following observations and suggestive inferences could be made:(a) Differences between regional estimates are non-trivial particularly true for the case of Domestic food for all household types and for all the consumption categories considered under the “0 NIE” and “≥4 NIE” household types, (b) In the case of Vehkolo, Non-food and services are relative luxuries and the two food consumption categories are relative necessities, (c) For Vahe’uta and for all household types, only imported food is the ‘clear’ relative necessity; and apart from Non-food of the “0 NIE” and “1 NIE” household types and
services of the “≥4 NIE” category, consumption categories other than imported food may be considered as relative luxuries, (d) the stylized patterns referred to in “b” and “c” above are

Table 4: MQES Estimates of Marginal Budget share and total Expenditure elasticities (Implicit correction – second stage: setting $\Gamma \equiv NIE$)

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Number of Income Earners (NIE)</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>≥ 4</th>
<th>Naïve $^1$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>A. Average Marginal budget share</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I. Vahekelo</td>
<td>Domestic food</td>
<td>0.21</td>
<td>0.21</td>
<td>0.21</td>
<td>0.17</td>
<td>0.18</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td>Imported food</td>
<td>0.45</td>
<td>0.34</td>
<td>0.31</td>
<td>0.32</td>
<td>0.40</td>
<td>0.34</td>
</tr>
<tr>
<td></td>
<td>Non-food</td>
<td>0.28</td>
<td>0.29</td>
<td>0.29</td>
<td>0.29</td>
<td>0.23</td>
<td>0.32</td>
</tr>
<tr>
<td></td>
<td>Services</td>
<td>0.06</td>
<td>0.16</td>
<td>0.19</td>
<td>0.23</td>
<td>0.18</td>
<td>0.14</td>
</tr>
<tr>
<td>II. Vahe’uta</td>
<td>Domestic food</td>
<td>0.18</td>
<td>0.19</td>
<td>0.20</td>
<td>0.18</td>
<td>0.17</td>
<td>0.19</td>
</tr>
<tr>
<td></td>
<td>Imported food</td>
<td>0.49</td>
<td>0.42</td>
<td>0.37</td>
<td>0.36</td>
<td>0.29</td>
<td>0.39</td>
</tr>
<tr>
<td></td>
<td>Non-food</td>
<td>0.13</td>
<td>0.23</td>
<td>0.27</td>
<td>0.28</td>
<td>0.40</td>
<td>0.25</td>
</tr>
<tr>
<td></td>
<td>Services</td>
<td>0.20</td>
<td>0.17</td>
<td>0.16</td>
<td>0.19</td>
<td>0.14</td>
<td>0.18</td>
</tr>
<tr>
<td><strong>B. Total expenditure elasticities</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I. Vahekelo</td>
<td>Domestic food</td>
<td>0.89</td>
<td>0.96</td>
<td>0.96</td>
<td>0.82</td>
<td>1.77</td>
<td>0.95</td>
</tr>
<tr>
<td></td>
<td>Imported food</td>
<td>1.14</td>
<td>0.76</td>
<td>0.84</td>
<td>0.76</td>
<td>1.05</td>
<td>0.83</td>
</tr>
<tr>
<td></td>
<td>Non-food</td>
<td>1.38</td>
<td>1.26</td>
<td>1.18</td>
<td>1.14</td>
<td>0.79</td>
<td>1.23</td>
</tr>
<tr>
<td></td>
<td>Services</td>
<td>-0.29</td>
<td>0.29</td>
<td>1.25</td>
<td>1.73</td>
<td>1.22</td>
<td>1.02</td>
</tr>
<tr>
<td></td>
<td>Average total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Expenditure (T$ per fortnight)</td>
<td>88.6</td>
<td>130.61</td>
<td>190.95</td>
<td>196.40</td>
<td>279.97</td>
<td>168.61</td>
</tr>
<tr>
<td>Number of observations</td>
<td></td>
<td>19</td>
<td>116</td>
<td>96</td>
<td>52</td>
<td>21</td>
<td>304</td>
</tr>
<tr>
<td>II. Vahe’uta</td>
<td>Domestic food</td>
<td>1.75</td>
<td>1.08</td>
<td>1.30</td>
<td>1.02</td>
<td>1.40</td>
<td>1.11</td>
</tr>
<tr>
<td></td>
<td>Imported food</td>
<td>0.90</td>
<td>0.91</td>
<td>0.86</td>
<td>0.81</td>
<td>0.83</td>
<td>0.87</td>
</tr>
<tr>
<td></td>
<td>Non-food</td>
<td>0.65</td>
<td>0.94</td>
<td>1.05</td>
<td>1.21</td>
<td>1.68</td>
<td>1.02</td>
</tr>
<tr>
<td></td>
<td>Services</td>
<td>1.94</td>
<td>1.27</td>
<td>1.15</td>
<td>1.15</td>
<td>0.50</td>
<td>1.28</td>
</tr>
<tr>
<td></td>
<td>Average total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Expenditure (T$ per fortnight)</td>
<td>83.23</td>
<td>97.55</td>
<td>153.71</td>
<td>152.29</td>
<td>248.30</td>
<td>125.13</td>
</tr>
<tr>
<td>Number of observations</td>
<td></td>
<td>30</td>
<td>203</td>
<td>119</td>
<td>32</td>
<td>21</td>
<td>405</td>
</tr>
</tbody>
</table>

$^1$ This corresponds to the implicit correction, first stage estimates (setting $\Gamma \equiv REGION$)
preserved even when corresponding estimates are generated for each of the two regions on the assumption that consumption patterns are uniform across the (NIE-based) household types.

It has been consistently revealed that imported food is ‘clear’ relative necessity. This result is made possible primarily by the fact that imported food dominates the budget shares of the Tongan Households. Moreover, needed to recall is the fact that the reported empirical works deal only with the market component of household consumption demand in Tonga. Thus, the showing of (market) Domestic food as a relative necessity for households at Vahekolo but as a relative luxury for households at Vahe’uta is in fact not surprising. Vahe’uta is essentially the rural sector of Tongatapu, constituted largely of households typically regarded as small agricultural holders. These “smallholders” are significantly involved in some agricultural productions for own account consumption. Moreover, in terms of the market expenditures the households of Vahekolo are clearly more affluent than their Vahe’uta counterparts (Table 4).

Further, More somewhat evidenced in these empirical results is an apparent weekliness in the comparability of estimates of marginal budget shares and total-expenditure elasticity estimates among households within the extreme types according to NIE (i.e, the “0 NIE” and ≥4 NIE” categories) and between these types and the other (i.e., “1 NIE,” and “3 NIE”) household types. At least two alternative explanations for these apparent differences (or the apparent lack of a reasonable degree of consistency) are available. First, the difference may reflect genuinely significant differences in consumption behaviors among these household types. Alternatively, the available degrees of freedom may have not been enough to adequately tap the variations in consumption patterns that are represented within these two extreme household types, and that are allowed for, by the parameters of the flexible MQES (Implicit Correction) variant.

(c) Estimates of price elasticities.

Table 5 presents estimates of both the uncompensated and compensated price elasticities for the two regions separately under the (Implicit Correction) MQES. For both regions, the magnitudes of the uncompensated cross-prices elasticities are quite small, with the majority near zero. However, all own-price elasticities have markedly large magnitudes. Imported food and Non-food are more elastic to own price changes among households at Vahekolo as compared to
households at Vahe’uta. The reverse tendency however, dominates the own-price elasticity estimates for Domestic food and services.

As revealed by these estimates (Table 5), the compensated cross-price elasticities are positive and not small. This result generally applies to both regions and all the four consumption categories (expect for a negative estimates [-0.18] for the compensated (quantity) elasticity of demand for services with respect to a change in the price of Non-food). Thus, evidentially, the influences of the income effects are non-trivial and hence, inter alia, these influences are ‘promoting’ all consumption categories to become net substitutes.

Table 5. MQES Estimates of Uncompensated and compensated Price Elasticities (Implicit Correction – First stage: Setting $\Gamma \equiv REGION$)

<table>
<thead>
<tr>
<th>Quantity Elasticity of</th>
<th>Domestic Food</th>
<th>With respect to the price of</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>imported food</td>
<td>non-food</td>
<td>Services</td>
</tr>
<tr>
<td>A. Uncompensated price elasticities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I. Vahekolo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic food</td>
<td>-0.99</td>
<td>-0.06</td>
<td>0.09</td>
<td>0.01</td>
</tr>
<tr>
<td>Imported food</td>
<td>-0.01</td>
<td>-1.03</td>
<td>0.19</td>
<td>0.03</td>
</tr>
<tr>
<td>Non-food</td>
<td>0.01</td>
<td>0.09</td>
<td>-0.28</td>
<td>-0.05</td>
</tr>
<tr>
<td>Services</td>
<td>0.02</td>
<td>0.01</td>
<td>-0.05</td>
<td>-0.99</td>
</tr>
<tr>
<td>II. Vahe’uta</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic food</td>
<td>-1.02</td>
<td>0.01</td>
<td>-0.01</td>
<td>0.04</td>
</tr>
<tr>
<td>Imported food</td>
<td>0.00</td>
<td>-0.97</td>
<td>0.02</td>
<td>0.03</td>
</tr>
<tr>
<td>Non-food</td>
<td>0.00</td>
<td>-0.04</td>
<td>-0.94</td>
<td>-0.05</td>
</tr>
<tr>
<td>Services</td>
<td>0.01</td>
<td>0.00</td>
<td>-0.13</td>
<td>-1.16</td>
</tr>
<tr>
<td>B. Compensated price elasticities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I. Vahekolo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic food</td>
<td>-0.79</td>
<td>0.32</td>
<td>0.33</td>
<td>0.14</td>
</tr>
<tr>
<td>Imported food</td>
<td>0.17</td>
<td>-0.69</td>
<td>0.39</td>
<td>0.14</td>
</tr>
<tr>
<td>Non-food</td>
<td>0.27</td>
<td>0.58</td>
<td>-0.96</td>
<td>0.11</td>
</tr>
<tr>
<td>Services</td>
<td>0.23</td>
<td>0.42</td>
<td>0.21</td>
<td>-0.86</td>
</tr>
<tr>
<td>II. Vahe’uta</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic food</td>
<td>-0.84</td>
<td>0.52</td>
<td>0.25</td>
<td>0.54</td>
</tr>
<tr>
<td>Imported food</td>
<td>0.15</td>
<td>-0.58</td>
<td>0.23</td>
<td>0.20</td>
</tr>
<tr>
<td>Non-food</td>
<td>0.18</td>
<td>0.42</td>
<td>-0.69</td>
<td>0.10</td>
</tr>
<tr>
<td>Services</td>
<td>0.23</td>
<td>0.58</td>
<td>-0.18</td>
<td>-0.98</td>
</tr>
</tbody>
</table>
This same pattern is also consistent with the ‘trend’ observed with respect to the estimates of compensated own-price elasticities – when uncompensated own-price estimates are adjusted to reflect genuine effects of ‘pure’ price changes. Notice that the consistent negativity in the signs of compensated own-price elasticities (for all consumption categories and for both regions) implies that this study empirically endorses the (Hicksien) “downward sloping-demand curve” hypothesis.

In the case of uncompensated price elasticities there appears to be some general agreement among the estimates within each region for the “1 NIE,” “2 NIE,” and “3 NIE” household types (see table 6). These estimates are also reasonably comparable with the ones obtained at the first stage (Table 5).

Generally, the estimates of uncompensated price elasticities procured under the “0 NIE” and “≥4 NIE” partitions differ from those procured under the other NIE-based household types (see table 7). These differences are particularly prominent in the cases of own (cross) price elasticities of (between) Non-food and services, and the case of quantity elasticity of demand for services is prompted by a change in the price of imported food in the case of Vaheko.olo.

In the case of the estimates of compensated price elasticities procured from the second stage set-up of the estimation (Table 7), the deviating features of the estimates procured under the “0 NIE” and “≥4 NIE” household types, as compared with the set of the estimates linked to the remaining (‘non-extreme’) household types, are still conspicuously evident. But however, continued to be consistently evident across household types are the claims that income effect are of non-trivial magnitudes, the consumption categories analysed are net substitues, and that the hypothesis that specifies compensated (hicksien) demand functions to be ‘sloping’ downwards is empirically endorsed.
Table 6. MQES (Estimates of Uncompensated price elasticities (implicit correction – second stage: setting \( \Gamma \equiv REGION \))

<table>
<thead>
<tr>
<th>Number of Income Earners (NIE)</th>
<th>Quantity elasticity of:</th>
<th>Domestic Food</th>
<th>Imported Food</th>
<th>Non-food</th>
<th>Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Vahekolo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>Domestic food</td>
<td>-0.96</td>
<td>-0.09</td>
<td>0.03</td>
<td>-0.02</td>
</tr>
<tr>
<td></td>
<td>Imported food</td>
<td>-0.06</td>
<td>-1.31</td>
<td>0.66</td>
<td>-0.44</td>
</tr>
<tr>
<td></td>
<td>Non-food</td>
<td>-0.12</td>
<td>0.80</td>
<td>-3.50</td>
<td>1.44</td>
</tr>
<tr>
<td></td>
<td>Services</td>
<td>0.21</td>
<td>-4.75</td>
<td>16.38</td>
<td>-11.55</td>
</tr>
<tr>
<td>1</td>
<td>Domestic food</td>
<td>-0.10</td>
<td>-0.10</td>
<td>0.08</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td>Imported food</td>
<td>-0.02</td>
<td>-1.04</td>
<td>0.18</td>
<td>0.13</td>
</tr>
<tr>
<td></td>
<td>Non-food</td>
<td>-0.05</td>
<td>-0.00</td>
<td>-1.07</td>
<td>-0.14</td>
</tr>
<tr>
<td></td>
<td>Services</td>
<td>0.02</td>
<td>0.12</td>
<td>-0.28</td>
<td>-1.15</td>
</tr>
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Table 7. MQES (Estimates of Compensated price elasticities (implicit correction — second stage: setting $\Gamma^\equiv REGION$)

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5. Conclusion

When one compares the estimates of summary statistics such as total-expenditure elasticity and uncompensated/compensated price elasticities derived from the (Implicit Correction) DQES and those derived from the QES – those estimated on the basic of the presumption that consumption patterns in Tonga are uniform across household demographic profiles (the Naïve specification) – one notices that marked differences exist.

This is no surprise given the emphatic support provided by the substantive empirical finding of this study in favor of inter alia, the following: (i) it is very important to take into account variations in household demographic profiles in examining consumption patterns, and (ii) it is essential to adopt sufficiently rich specification in the analysis of consumption patterns. These are crucial since variations in demographic variables somewhat interact and operate in complex ways. Thus, the adoption of the approach (Implicit Correction specification) of allowing all parameters of the demand system to depend on demographic variables represents an affective above-threshold requirement.

Nudged by its strong findings, this study has empirically stylized consumption patterns in Tonga in an appropriate way. Thus, inter alia, the sets of demographically adapted parameter and elasticity estimates and other behavioral (summary) statistics provided, serve to convey economically meaningful and perspective stories about consumption behavior in Tonga; and for that matter, about consumption behaviors in pacific island economies which are still entwined within a development stage akin to that of Tonga. These stories need to be fruitfully translated into relevant management and policy inputs. If and when practicing economists/policy analysts in these developing island nations channel efforts into this task, the boundaries to the inferential and predictive scopes of the said empirical harvest as delineated and implied by the underlying conceptual and empirical science foundation of the adopted methodology, need to be perpetually respected.
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\[2005/WP:\]


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<table>
<thead>
<tr>
<th></th>
<th>Authors</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>T.K. Jayaraman</td>
<td>A Single Currency for the South Pacific Island Islands: A Dream or A Distant Possibility?</td>
</tr>
<tr>
<td>4</td>
<td>TK Jayaraman &amp; Rajesh Sharma</td>
<td>Determinants of Interest Rate Spread in the Pacific Island Countries: Some Evidence From Fiji.</td>
</tr>
<tr>
<td>5</td>
<td>Ravinder Batta</td>
<td>Ecotourism and Sustainability.</td>
</tr>
<tr>
<td>6</td>
<td>Ravinder Batta</td>
<td>Measuring Economic Impacts of Nature Tourism.</td>
</tr>
<tr>
<td>7</td>
<td>TK Jayaraman &amp; BD Ward</td>
<td>Efficiency of Investment in Fiji: Results of an Empirical Study.</td>
</tr>
<tr>
<td>8</td>
<td>Azmat Gani</td>
<td>High Technology Exports and Growth – Evidence from Technological Leader and Potential Leader Category of Countries.</td>
</tr>
<tr>
<td>9</td>
<td>B. Bhaskara Rao</td>
<td>The Nature of The ADAS Model Based on the ISLM Model.</td>
</tr>
</tbody>
</table>