Economic Issues, Vol. 8, Part 2, 2003

An Error Correction Model of the Median Voter's Demand for Public Goods in Mauritius

Sanjeev K Sobhee[1]

ABSTRACT

From an optimizing framework, the median voter's demand for public goods is derived and estimated using data pertaining to the economy of Mauritius over the period 1970-1999. Empirical findings reveal that a long run relationship exists between the quantity demanded of public goods and the income of the median voter, the latter's perceived tax price (for these goods) and overall population. Public goods are found to be basic necessities rather than luxury goods. Moreover, the rising number of beneficiaries generates an increase in the demand for public goods, though not in a manner that would substantiate the congestion hypothesis. A disaggregation of the temporal elasticities through the formulation of an Error Correction Mechanism indicates that, while in the short run, it is basically the perceived tax-price variable which predominates, in the long run, all the three variables — price, income and population become significant in influencing the median voter's demand. A major policy implication emanating from these findings is it may be necessary but not sufficient to curb public spending by simply eliminating fiscal deficits.

1. INTRODUCTION

Musgrave (1959) established the three major objectives of a government, namely, allocation of resources, distribution of income and wealth and stabilization of the economy. However, as a collective decision-maker, the government tries to generate the optimal mix of public expenditure and revenue that best fits the preferences of the median voter in achieving these objectives. Current empiricism in the public choice area focuses a lot on the characteristics and dynamics, which govern public spending, whereby demand functions for public goods have been modelled exclusively.[2] Empirical median voter's demand functions are usually built from the pioneering works of Borcherding and Deacon (1972) and Bergstrom and Goodman (1973). These studies were basically undertaken to model the major factors that determine the demand for public services. Rubinfeld (1987) summarized the findings on median voter's demand for public goods by establishing that most studies revealed income elasticities which were less than unity and price elasticities clustering between -0.2 and -0.4. These empirical findings suggest that, by and large, public goods or services are viewed as basic necessities by tax payers. Furthermore, the occurrences of fiscal deficits in both developed and developing economies have prompted a few researchers to estimate demand functions for public goods in their attempt to link growth of public expenditure with fiscal deficits. In fact Buchanan and Wagner (1977) provided a hypothesis that could explain higher fiscal deficits through a reduction in the perceived tax-price of public goods, which in turn generates higher demand for such goods. Niskanen (1978), Provopoulous (1982), Khan (1988) and Ashworth (1995) have found evidence in support of the Buchanan and Wagner (1977) hypothesis from alternative country data sets.

Contrary to these findings on demand functions and voters' perceptions of the tax price, Dudley and Montmarquette (1981) challenged the view that median voter's preferences constitute the basis for public sector's spending. Indeed, as reinforced by Dao (1995), the influence of the median voter on public sector's output is governed by a host of factors which are highly susceptible to time series and cross-country variations. Therefore, to address the empirical ambiguity, which still remains in modelling and analysing median voter's demand for public goods, further investigation is warranted.

Hence, in this paper, we intend to extend the literature by modelling exclusively a relevant median voter's demand function for public goods and testing it using data pertaining to the small island economy of Mauritius. In fact, there are specific factors that prompt an empirical investigation of the median voter's demand for public goods in Mauritius. First, due to the economic backwardness of the country during the post independence era, public expenditure was dictated by a Keynesian-type ideology and was thus demand-driven. Given the low tax-base and a binding budget constraint in those years, the government had recourse to high fiscal deficits (often exceeding five per cent of GDP) that subsequently turned out to be a recurrent feature of the country's public finances. In this context we intend to test the Buchanan and Wagner (1977) hypothesis and establish the link between demand for public goods, the perceived tax-price of the median voter and fiscal deficits. Moreover, since Mauritius is a small island, covering an area not exceeding 720 sq miles, this makes it vulnerable to the congestion effect associated with the increasing population (currently 1.2 million), in general, and its density in particular. Altogether in recent years, the economy experienced a growth rate averaging five per cent in real terms, thereby improving the macroeconomic fundamentals including the public finances. Thus it would be interesting to capture and analyse the evolutionary forces that have governed the demand for public goods in Mauritius over the last three decades through temporal elasticities.

2. The model

We adopt a median voter's approach to the collective choice problem in which the individual voter maximizes utility subject to a given budget constraint. It is assumed that preferences of the median voter '*i*' are represented by a Cobb-Douglas utility function in a manner described below:

$$U^i(G, X_i) = aG^{\theta_1} X_i^{\theta_2} \tag{1}$$

Where G represents a composite public good, X_i represents a private good, a is a constant term and θ_1 and θ_2 are impact elasticities. Here we should note that, in contrast to the private good, the median voter alone is unable to decide directly on the amount that he wants to consume of the public good. In fact, the consumption decision of any publicly provided good is undertaken on a collective rather than on an individual basis. As such, a fundamental divergence exists between the amount available for consumption (that is, G and the amount paid for by the median voter (say G_i). This arises because of the increasing population and hence the number of beneficiaries of public goods. What actually happens is that there are beneficiaries who do not necessarily pay for such goods but still have the right to participate in their consumption due to the principles of equity and non-excludability. Put differently, this simply means that the median voter, *ex-ante*, buys amount G_i but finds himself, *ex-post*, consuming G. To further understand the relationship between G and G_i, it is more appropriate to consider the congestion or crowding function:

$$G = (G_i / N^{\gamma}) \qquad \gamma > 0 \tag{2}$$

In this function, N stands for the population level and γ refers to a crowding parameter, while G and G_i are as defined above. Such specification is commonly cited in the literature. See Cornes and Sandler (1996), for instance, for a theoretical exposition. G is inversely related to N based on the premise that public goods are non-excludable; an increase in the number of beneficiaries, or population as a whole, will reduce accessibility to publicly provided goods (especially for publicly provided private goods or merit goods, such as education and health, which are highly subsidized). Long queues and delays in delivery of public services coupled with a degradation of the quality of such services are mere manifestations of this congestion effect.

With reference to the crowding function specified above; as an extreme case, in the event there is no crowding effect, $\gamma = 0$ and in which case, the values of G and G_i coincide. As a result, the amount available for consumption by the median voter is exactly equal to the amount, which he has paid for and expects to consume. Alternatively, if $\gamma > 0$, the congestion effect is said to exist and will imply that the amount available for consumption is below what the beneficiary has paid for. Such is the case we want to emphasise and analyse in this paper. Needless to say, the congestion effect will lead to the following loss of utility:

$$(\delta U_i/\delta N) = -(\theta_1 \gamma U^i/N) < 0 \tag{3}$$

Also, one needs to observe that the agent has to gradually adjust G_i proportionately with the growth rate of N to overcome the effect of congestion and the subsequent loss of utility. [3]

On the other hand, in addition to the utility function, there exists correspondingly a budget constraint, whose standard form (see for example Stiglitz (1988)), expressed in real terms is given by:

$$GP_{G_i} + X_i = Y_i \tag{4}$$

where P_{Gi} is the relative price of the public good (actually the tax-price perceived by the median voter) and Y_i is the median voter's real income. Note that the budget constraint is based on the amount of the public good that the median voter perceives he or she will receive, which includes any potential loss due to the congestion effect. The maximization exercise follows the stylized Lagrangean formulation as given below:

$$L = aG^{\theta_1}X_i^{\theta_2} + \lambda\left[GP_{G_i} + X_i - Y_i\right] \tag{5}$$

Solving this leads to the following demand for G

$$G = \left(\frac{Y_i}{P_{G_i}}\right) \cdot \left(\frac{1}{1+\left(\frac{\theta_2}{\theta_1}\right)}\right) \tag{6}$$

Substituting $G = (G_i / N^{\gamma})$ from the crowding function into (6) then gives the following implied demand for G_i

$$G_i = \left(\frac{Y_i}{P_{G_i}}\right) \cdot \left(\frac{1}{1+\left(\frac{\theta_2}{\theta_1}\right)}\right) N^{\gamma} \tag{7}$$

In other words, we have the willingness and ability to pay function for public goods as

$$G_i = f(Y_i, P_{G_i}, N) \tag{8}$$

Which, when expressed in log-linear and temporal form, generates:

$$log\ G_{it} = logA_i + A_1 logY_{it} + A_2 logP_{Gi} + A_3 log\ N_t \tag{9}$$

Equation (9) represents our estimable median voter's demand function for public goods. Here we find that this demand depends on the real income of the median voter, the latter's perceived price of the composite public good and the number of beneficiaries as represented by the population level. $LogA_i$ is a constant term. The expected signs of the coefficients in equation (9) are dictated by the partial derivatives of equation (7). Thus it follows that $\frac{\partial G_i}{\partial Y_i} > 0$, $\frac{\partial G_i}{\partial P_{G_i}} < 0$ and $\frac{\partial G_i}{\partial N} > 0$.

We expect $A_1 > 0$, suggesting that public goods are normal; but whether $A_1 < 1$ or $A_1 > 1$ remains an empirical issue. In the former case, it will imply that public goods are necessities; otherwise they are luxury goods. The coefficient of A_2 is expected to be negative following the normal good hypothesis. Lastly, the coefficient of N, that is A_3, is expected to be positive, with a coefficient exceeding unity to particularly reflect congestion effects. In the following section, equation (9) is estimated and the empirical findings are discussed thereafter.

3. Data and empirical issues

Data for the period 1970-1999, which have been obtained from the annual issues of Government Finance Statistics and International Financial statistics, are used to estimate equation (9). For the purpose of illustrating the kind of trend characterizing the data to be used in the empirical exercise, a time series plot of each variable is shown in Figures 1(a) and 1(b). With the exception of $log\ P_{Gi}$, all the variables shown depict a smoothly increasing trend.

Figure 1(a): Time Series plot of variables $log\ G_i$ and $log\ Y_i$

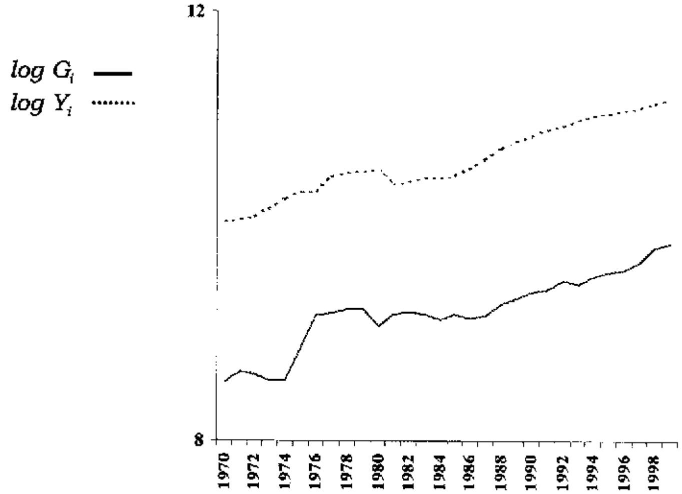
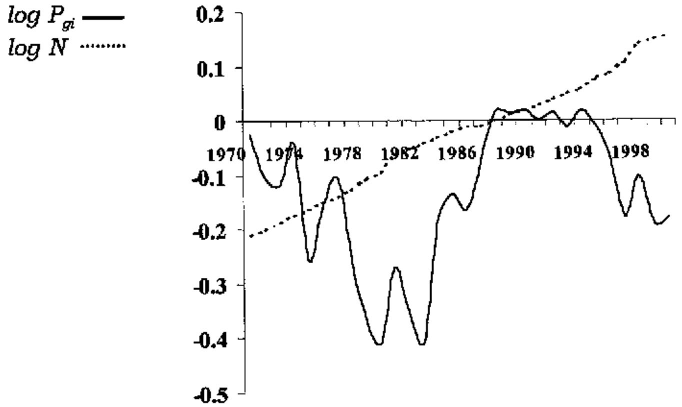


Figure 1(b): Time series plot of variables *log* P_{gi} and *log N*



Source: *Government Finance Statistics* and *International Financial Statistics*, annual issues.

In the case of *log* P_{Gi}, we find that this variable has been fluctuating rather than depicting a smooth trend. In the foregoing empirical exercise we use real total public expenditure per capita for variable G_i and real per capita income for variable Y_i. As these variables are not directly observable, mean values are often used to represent them (for example, see Borcherding and Deacon (1972) and Ashworth (1995)). Besides, given that Mauritius has a two-party electoral system and the latter is consistent with the median voters' total expenditure (Stiglitz (1988)), then this makes it more suggestive to use mean values as indicators of the median voter's quantity demanded and income. Also the empirical measure of G_i is meant to capture the public sector activity in its broadest sense and subsequently encompasses not only pure public goods but as well as the public provision of private goods. It is also pertinent to retain such coverage while addressing issues pertaining to consolidated fiscal deficits. In addition, for a country like Mauritius, public spending is in large part dictated by education and health, the first two most expensive government budgets. However, since education and health are provided freely by the state (hence available to all), it would make little sense to avoid these items and concentrate only on the pure public goods aspects. The variable P_{Gi} is constructed by dividing total tax revenues by total public expenditure in real terms and constitutes the average perceived tax-price of the composite public good faced by the median voter. The extra amount that a consumer needs to pay for any additional unit of the public good consumed is reflected in this definition. The methodology applied (also adopted by Khan (1988) for a developing country case) has got two major implications; firstly, in testing the Buchanan and Wagner (1977) hypothesis, it is a relative measure in terms of current versus future tax prices. To explain this, let us consider the conventional government budget constraint in which $TPE = R + B$, where TPE stands for the total tax base or total public expenditure, R stands for total taxes received/paid and B stands for debt issued (future tax liabilities). Thus, (R/TPE) will represent the price currently borne by each citizen taxpayer while (B/TPE) will represent higher future prices as perceived by the latter. Secondly, in Mauritius, around 75 per cent of the total tax earnings are generated by indirect taxes, implying their relative degree of insulation against any fluctuation in income as opposed to direct taxes. Unemployment benefits, on the other hand, are not a feature of the government's fiscal policy. However, before actually estimating equation (9), we first analyse whether our variables are all stationary. The Augmented Dickey Fuller (ADF) test based on Dickey and Fuller (1979) and (1981) is applied for this purpose using the equation:

$$\Delta Z_t = \alpha_0 + \alpha_1 T + \alpha_2 Z_{t-1} + \sum_{t}^{m} \beta \Delta Z_{t-1} + \varepsilon_t \tag{10}$$

Where Z_t is any variable at time t, T is time trend and ε_t is a random error assumed to be independently and identically distributed. We do control for trend non-stationarity as well given that this appears to be a prominent characteristic of our series as revealed in Figures 1(a) and 1(b) above. When the above test is applied to the variables in equation (9), it is found that none is stationary. Moreover, when all variables are differenced once, and the unit root test is applied again, the hypothesis of non-stationarity is rejected. This means that our variables are integrated of the same order, i.e., they are all I (1).

Table 1 reports these statistics conditional on a standard critical ADF at 5 per cent level of significance that equals to -3.6 (value based on MacKinnon (1991)) and the corresponding lag length as indicated by the relevant value of Akaike Information Criterion (AIC).

Table 1: Unit root test of variables

Variable	*Computed ADF*	*Optimal Lag Length*
G_{it}	-2.6	1
ΔG_{it}	-3.86*	1
Y_{it}	-2.14	3
ΔY_{it}	-4.13*	0
P_{Git}	-1.1	4
ΔP_{Git}	-4.6*	1
N_t	-1.6	0
ΔN_t	-4.8*	1

Source: Author's computation. Notes: (i) The computed ADF statistic in level form contains a time trend for all the variables shown; (ii) * indicates significance at 5% (iii) In the case of variable '*p*', since no discernible trend is found, the ADF test with and without a trend is considered and in both cases, it is found to be non-stationary.

Having confirmed that all our variables are integrated of the same order, we proceed by estimating the co-integrating equation (9) using OLS. The empirical results are as follows:

$$\underset{}{logG_t} = \underset{(0.67)^*}{1.99} + \underset{(0.042)}{0.67logY_t} - \underset{(0.048)}{0.49logP_{gt}} + \underset{(0.082)}{1.11logN_t} + \mu_t \tag{11}$$

$R^2 = 0.89$ F = 78.3(0.00) RESET(1) = 1.44(0.23)
LM(3) = 4.2(0.061) ARCH = 5.2(0.16) JB(2) = 2.4(0.072) CPF = 1.3(0.73)

(Probability values in parentheses)

At the 5 per cent level of significance, the computed ADF statistic of order 1 of the residuals, emanating from this equation as indicated by Akaike Information Criterion (AIC), is found to be -6.41, which far exceeds the critical value of -4.56, in absolute terms. The result therefore indicates that the errors are random, and that a co-integrating or long term relationship exists between the dependent variable and the right-hand side variables. This is also confirmed by the insignificance of the Lagrange Multiplier (LM) statistic. We altogether confirm the relevant specification of those results from Ramsey's RESET test that allows us to reject the hypothesis of misspecification. Three other test statistics are also presented, namely, Autoregressive Conditional Heteroskedasticity (ARCH), Jarque Bera (JB) test of normality of residuals and Chow's Predictive Failure test (CPF) based on a sample break at 1982. All test statistics comply with the usual norms.

At this stage it is important to observe that since the analysis is being carried out in a multivariate set-up, it would make more sense to use a multivariate method such as the Johansen technique (Johansen (1988)) to determine the possibility of other co-integrating vectors among our variables and deriving more efficient and reliable estimates. Given the small size of our sample and our specific objective of estimating that co-integrating vector pertaining to a demand function, we stick to the single-equation method while ensuring the robustness of our estimates by, firstly, confirming the exogeneity of the regressors,[5] and secondly, by controlling for small sample bias (see for instance Banerjee *et al.* (1986,1993) and Wickens and Breusch (1988) on small sample biases in applying the Engle-Granger methodology). Hence, to address the first problem, we perform weak exogeneity tests of the regressors, namely, *Y*, *P* and *N*, in the above co-integrating equation and in the subsequent Error Correction Mechanism (ECM). In this context, we apply the Wu-Hausman Test, detailed in Wu (1973) and Hausman (1978), whose results for both the co-integrating equation and the corresponding ECM[6] are summarized in Table 2. Secondly, to overcome the problem of biasness, we apply a methodology often proposed in the literature (see Banerjee *et al.* (1986) for example), of determining jointly the short run and long run elasticities in the ECM. As such, this would imply that we use the Engle-Granger methodology up to detecting co-integration between the dependent variable and the independent variables only. Results of these two experiments are now discussed.

Table 2: Wu-Hausman test of weak exogeneity

	Type of equation	
Variables	*Co-integrating Equation*	*ECM**
Income	3.92	0.37
Price	2.43	0.982
Population	0.009	0.465
All Regressors	1.24	0.591

Source: Author's Computation.
Note: * We apply this test to the unrestricted ECM (see Table 3)

In table 2, neither of the Wu-Hausman test statistics reported is significant at the 5 per cent level. Hence, we conclude that the variables used in both equations are weakly exogenous and the estimates are therefore efficient.

In the ECM we determine the optimal lag-length of each of the explanatory variables according to the AIC, and this turns out to be 4 in an unrestricted model. However, we apply Hendry's General to Specific approach subsequently to capture the relevant short run dynamics and eliminate insignificant variables through the re-estimation of the ECM in a restricted form. The general specification for this ECM is given by:

$$\Delta LogG = \sum_{j=1}^{4}\chi_j \Delta LogG_{t-j} + \sum_{k=1}^{4}\phi_k \Delta LogY_{t-k} + \sum_{l=1}^{4}\varphi_l \Delta LogP_{g,t-l} + \sum_{m=1}^{4}\omega_m \Delta LogN_{t-m} \quad (12)$$
$$+\sigma LogG(-1) + \mu LogY(-1) + \zeta LogP_g(-1) + \pi LogN(-1) + \xi_t$$

To obtain the long run elasticities, we re-parameterise equation (10) as follows:

$$\Delta LogG = \sum_{j=1}^{4}\chi_j \Delta LogG_{t-j} + \sum_{k=1}^{4}\phi_k \Delta LogY_{t-k} + \sum_{l=1}^{4}\varphi_l \Delta LogP_{g,t-l} + \sum_{m=1}^{4}\omega_m \Delta LogN_{t-m} \quad (13)$$
$$+\sigma[LogG(-1) + (\mu/\sigma)LogY(-1) + (\zeta/\sigma)LogP_g(-1) + (\pi/\sigma)LogN(-1)] + \xi_t$$

In equation (13), the speed of adjustment of the dependent variable towards the long-run relationship following any temporary deviation from this relationship is given by σ. Moreover, the long run elasticities are tracked by (μ/σ) for income, (ξ/σ) for price and (π/σ) for population. We wish to point out at this stage that to strengthen our reliability on the above approach in an empirical context, a non-nested test is also performed between the single-step model (Equation (12)) and the two-step model (the standard Engle-Granger's ECM). Based on both AIC and J tests, the single-step ECM model is favoured; and the above equation is empirically estimated. The results are displayed in Table 3. An analysis of the diagnostics clearly reveals to what extent the elimination of incorrect dynamics in the restricted ECM improves the diagnostic tests, in particular, the LM test for serial correlation and the RESET test for functional form. By and large, all reported test statistics are within the acceptable norms as denoted by their corresponding probability values.

Table 3: ECM results in unrestricted and restricted form

explanatory variables	*unrestricted version* coefficient	*unrestricted version* T-ratio	*restricted version* coefficient	*restricted version* T-ratio
$\Delta logG(-1)$	0.92	2.89*	0.65	3.23*
$\Delta logG(-2)$	0.46	1.58**	0.46	1.78**
$\Delta logG(-3)$	0.76	2.59*	0.54	2..37*
$\Delta logG(-4)$	0.25	1.08***	_	_
$\Delta logY(-1)$	-0.0002	-1.15***	_	_
$\Delta logY(-2)$	-0.0003	-2.11**	-0.0002	-1.49***
$\Delta logY(-3)$	-0.0001	-0.55***	_	_
$\Delta logY(-4)$	-0.0001	-0.62***	_	_
$\Delta logP(-1)$	1.18	2.77*	1.04	3.11*
$\Delta logP(-2)$	0.45	1.78***	0.39	1.82**
$\Delta logP(-3)$	0.49	1.82**	0.45	2.18*
$\Delta logP(-4)$	-0.17	-0.72***	_	_
$\Delta logN(-1)$	1.03	0.40***	_	_
$\Delta logN(-2)$	3.50	0.96***	_	_
$\Delta logN(-3)$	4.79	0.99***	_	_
$\Delta logN(-4)$	-3.86	-0.62***	_	_
$logG(-1)$	-1.76	-4.04*	-1.63	-4.42*
$logY(-1)$	1.52	4.04*	1.41	4.43*
$logP(-1)$	-0.59	-1.82**	-1.04	-3.1*
$logN(-1)$	0.62	1.79**	0.77	2.19*

Diagnostics

$\bar{R}^2 = 0.82$	$\bar{R}^2 = 0.54$
F = 6.7	F= 3.9
LM = 4.6 (0.032)	LM = 2.35 (0.13)
RESET = 15.6 (0.00)	RESET = 0.60 (0.44)
JB = 0.14 (0.934)	JB = 1.00 (0.61
ARCH = 2.78 (0.43)	ARCH = 3.24 (0.36)
CHOW's = 0.63 (0.28)	CHOW's = 0.69 (0.31)

Notes: (i) *indicates significance at less than 5%;** indicates significance at less than 10% and *** indicates insignificance. (ii) The probability value for each diagnostic test is indicated within brackets. (iii) Chow's Predictive Failure test uses a sample break at 1982.

From Table 3, we can summarise the results emanating from the restricted version of the ECM, in particular the adjustment parameter and the short run and long run elasticities. The adjustment parameter is negative and significant. Being negative and high in magnitude, it clearly reveals that quantity consumed of public goods does adjust relatively fast towards its long-term relationship with the regressors in question. For the sake of convenience, the elasticities have been tabulated in Table 4.

Table 4: Temporal elasticities

	elasticities	
variable	*short-run*	*long-run*#
Y	-0.004***	0.87*
P	1.88**	-1.04*
N	0.00***	0.47*

Notes: (i) * Indicates significance levels as defined under Table 3. (ii) # implies that the long-run elasticities are determined after re-parameterisation of the restricted ECM.

The short run figures reveal that only price turns out to be a significant variable that has an impact on the demand for public goods. Its coefficient happens to be positive and elastic. This leads to a straight-forward rejection of the Buchanan and Wagner (1977) hypothesis. The case of Mauritius substantiates that in the short run, any price increase would be accompanied by a more than proportionate increase in the demand for public goods. This happens to be the case since people judge the relative importance of these goods through the price that they pay. An increase in the price could be viewed as an improvement in the quality of services delivered by the public sector and hence the willingness to demand more as price rises. On the other hand, both income and population have no short-run impact on the demand for public goods. The empirical explanation for the insensitivity of consumers to a change in income is probably due to the fact that they are more concerned with private rather than public goods, especially when they are liquidity constrained. Altogether, this does not provide any evidence of the Wagnerian hypothesis of high income elasticity. Regarding population, since the latter does not grow much from one short period to another, this factor will undoubtedly have no significant influence on the demand for public goods in the short-run.

On the other hand, it can be found that all the long run elasticities generated are significant and consistent with the theoretical postulates. In the long run, since $A_1<1$, we can therefore robustly claim that public goods are necessities. Based on this long run coefficient, we can also comment on the Wagner's Law. The latter predicts that as income increases, public expenditure will rise more than proportionately. This occurs because the demand for some specific public goods, having an elastic base, will rise.[7] In our long-term equation, since the coefficient of income is 0.87 and hence lies below unity, we reject the Wagnerian hypothesis again. Alternatively, the negative coefficient on P here tends to support the Buchanan and Wagner (1977) hypothesis. Given a decrease in the perceived tax-price of public goods, the demand for such goods will increase in the long run. Hence, given that fiscal deficits have been a recurrent feature of the Mauritian public finances in the past, this would signal a reduction in the perceived tax price of such goods eventually causing higher public spending. Lastly, the coefficient on population is 0.47, implying that demand grows as population grows. However, what is worth noting here is that congestion effects are not prevalent in the case of Mauritius. One can explain this through the degree of 'publicness' of the public goods in Mauritius. In clearer terms, for congestion effects to occur, an increase in population must be accompanied by a more than proportionate increase in quantity demanded of public goods. In the current context, this is not the case because there has been equally an increasing demand for private goods that directly compete with some publicly-provided private goods such as education, health and transport. In recent years the increasing participation of the private sector in supplying such competing goods for a more profitable cause has dampened the congestion effects to a large extent.

4. Conclusion

This paper provides additional insights through the empirical evidence of the median voter's demand function for the public goods in a developing small island economy. We first establish a long-term relationship between quantity demanded of public goods, median voter's income, price and population. Supporting evidence in favour of the Buchanan and Wagner (1977) hypothesis is found in the Mauritian context implying that fiscal deficits have led to a reduction in the perceived tax-price of public goods that have further increased public spending. In addition, we establish that public goods are necessities. It is also found that as population increases, there is a less than proportionate increase in the quantity demanded for public goods. This clearly signals the absence of congestion effects, which are generally expected to occur with an increase in population density. However, since there has been correspondingly an increasing demand for privately provided merit goods, such as education and health, over the last few decades, this has largely dampened the congestion effects. No evidence in favour of Wagner's law is found over the long run since income elasticity of demand for public goods is found to be strictly less than unity. However, the Error Correction Mechanism also allows us to conclude that in the short run only the price variable matters. Its positive sign tends to reveal that beneficiaries are willing to demand more of such goods as their perceived price rises. By and large, we can say that the long run estimates of elasticities conform to conventional wisdom.

Summing up, it would be good to observe a major policy implication of these findings that it is necessary but not sufficient for the government to curb public spending by simply eliminating fiscal deficits. It would also be a challenge to consider, beyond the growing median voter's income, growth of population altogether with private sector's involvement in supplying goods having public characteristics.

Accepted for publication: 13th May 2003.

ENDNOTES

1. Department of Economics and Statistics, University of Mauritius, Réduit, Mauritius; Tel: +230-4541041 Fax: +230-4656184. Email: sksobhee@uom.ac.mu. I would like to thank two anonymous referees and the editor of the journal for many useful comments. Remaining errors are my own.

2. For a good review (both theoretical and empirical) of alternative demand functions for public goods (including environmental goods) see Cornes and Sandler (1996).

3. Observe that using total differential, one can prove that for $\dot{G} \succ 0$, it is necessary and sufficient that $G \succ \gamma \dot{N}$, that is, the beneficiary has to adjust G_i such that its growth rate exceeds $\gamma \dot{N}$ to increase the availability of the public good G to all (Here, a dotted variable indicates growth rate of that variable).

4. Note that *R/TPE* represents the average rate of tax perceived by the median voter, since this ratio can be expressed as $(R/N)/(TPE/N)$, that is, *per capita* tax as a proportion of per capita government expenditure.

5. Harris (1995) for instance reports that when all the right-hand side variables in a single-equation model are weakly exogenous, this method is likely to generate efficient estimates as one would expect from a multivariate technique, such as the Johansen approach.

6. For a good review on the usefulness and applications of ECMs, see Thomas (1997).

7. For a recent discussion of the Wagner's Law see Payne and Ewing (1996).

REFERENCES

Ashworth J (1995) 'The empirical relationship between budgetary deficits and government expenditure growth: an examination using co-integration', *Public Finance/Finances Publiques*, 50, 1-18.

Banerjee A Hendry D F and Smith G W (1986) 'Exploring equilibrium relationships in econometrics through static models: some Monte Carlo evidence', *Oxford Bulletin of*

Economics and Statistics, 52, 95-104.

Banerjee A Dolado J J Galbraith J W and Hendry D F (1993) 'Co-integration, error correction, and the econometric analysis of non-stationary data', *Advanced text in econometrics*, Oxford: Oxford U P.

Bergstrom T and Goodman R (1973) 'Private demand for public goods', *American Economic Review*, 63, 280-296.

Borcherding T and Deacon R (1972) 'The demand for services of non-federal government', *American Economic Review*, 62, 891-901.

Buchanan J and Wagner R (1977) *Democracy in deficit: the political legacy of Lord Keynes*, New York: Academic Press.

Cornes R and Sandler T (1996) *The theory of externalities, public goods and club goods*, Cambridge: Cambridge U P.

Dao M Q (1995) 'Determinants of government expenditures: new evidence from disaggregative data', *Oxford Bulletin of Economics and Statistics*, 57, pp. 67-76.

Dickey D A and Fuller W A (1979) 'Distribution of the estimators for autoregressive time series with a unit root', *Journal of American Statistical Association*, 37, pp. 427-31.

Dickey D A and Fuller W A (1981) 'Likelihood ratio statistics for autoregressive time series with a unit root', *Econometrica*, 49, 1057-1072.

Dudley L and Montmarquette C (1981) 'The demand for military expenditures: an international comparison', *Public Choice*, 37, 5-31.

Harris R (1995) *Co-integration analysis in econometric modelling*, London: Prentice-Hall.

Hausman J A (1978) 'Specification tests in econometrics', *Econometrica*, 46, 251-272.

IMF (Various Issues), *Government Finance Statistics*, New York.

IMF (Various Issues), *International Financial Statistics*, New York.

Johansen S (1988) 'Statistical analysis of co-integration vectors', *Journal of Economic Dynamics and Control*, 12, 231-254.

Khan A H (1988) Public spending and deficits: evidence from a developing economy, *Public Finance/Finances Publiques*, 43, 396-402.

MacKinnon J G (1991) 'Critical values for co-integration tests in long-run economic relationships', in Engle R F and Granger C W J (eds), *Readings in Co-integration*, Oxford: Oxford U P.

Musgrave R A (1959) *The theory of public finance,* New York: McGraw Hill.

Niskanen W A (1978) 'Deficits, government spending, and inflation: what is the evidence?', *Journal of Monetary Economics,* 4, 591-602.

Provopoulous G A (1982) 'Public spending and deficits: the Greek experience', *Public Finance/Finances Publiques,* 37, 422-427.

Payne J E and Ewing B T (1996) 'International Evidence on Wagner's Hypothesis: A Co-integration Analysis', *Public Finance/Finances Publiques,* 51, 258 – 274.

Rubinfeld D (1987) 'The economics of the local public sector', in Auerbach A J and Feldstein M (eds) *Handbook of public economics,* Vol. II, Amsterdam: North-Holland.

Stiglitz J E (1988) *Economics of the public sector,* New York: Norton and Co.

Thomas R L (1997) *Modern econometrics,* Harlow-Reading: Addison Wesley Longman.

Wickens M R and Breusch T S (1988) 'Dynamic specification, the long run and the estimation of transformed regression models', *Economic Journal,* 98, (supplement), 189-205.

Wu D M (1973) 'Alternative tests of independence between stochastic regressors and disturbances', *Econometrica,* 41, 733-750.