PUBLIC TRANSPORT FARE SUBSIDIES FOR CHILDREN AND THE ELDERLY IN DEVELOPING COUNTRIES

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ABSTRACT

A modification to an earlier formula for estimating public transport subisidisation requirements for developing countries is presented. The modification has been made to make the formula cater for the travel money expenditure needs of school going children and the elderly. As with the earlier formula, the present one is designed for both regulated and deregulated transport markets. It yields a subsidy level that is commensurate with the level of control a government is able to exercise over public transport operation. The modification is based on subsidizing school trips by school children as a matter of course, but giving subsidy for trips by the elderly conditional upon it being determined in the first instance that subsidy is required.

INTRODUCTION

A procedure has recently been developed (Osula, 1998a) for estimating urban public transport subsidisation requirements for developing countries. The procedure is based on a subsidisation policy of reducing transport expenditure burden on the average commuter by maintaining his transport expenditure-income ratio at a reasonable level. The subsidisation formula yields a level of subsidy that is commensurate with the level of control a government is able to exercise over public transport operations. It is meant for use in countries in which personal transport allowances are given to workers in addition to their basic salaries, as is the case in Nigeria, and in a situation where the travel expenditure-income ratio bears an inverse relationship with income as has been proved to be very much the case for many developing countries (See for example Ojumu (1975), Heraty (1980), Eastman and Pickering (1981), Jacobs et al (1981), Maunder (1984) and Osula (1998b).).

The procedure yields an across-the-board subsidy, having been designed to cater for the average trip maker. Thus in order for it to be of direct benefit to specific segments of the society such as school children and the aged, some form of modification or refinement is necessary. From work carried out to investigate the October 1994 fuel price increase in Nigeria (as part of a major research to examine the functional form of travel money expenditure and its stability with respect to energy policy change in Nigeria (Osula, 1998b)), it was established that there is a need to evolve energy cum transportation policies that will ensure preferential treatment for the elderly in the society, this group of persons having been found to be the most affected by the October 1994 fuel price increase in terms of increase in travel money expenditure. The transport policy component that readily comes to mind is subsidisation of public transport to reduce travel expenditure burden for this category of people.

This present work has been carried out to give quantitative expression to such a policy component. Specifically, what is presented herein is a modification or refinement of the earlier subsidisation formula, to address additionally the situation where the demand side of the transport market comprises of an appreciable proportion of the elderly. The modifications are in the first instance to include subsidisation for school trips made by school children. School children are undoubtedly plentiful in an average Nigerian city and their travel expenditures are part of the out-of-pocket expenditures of the adult tax payer in addition to his own personal travel money expenditures.

There are obvious benefits (to all concerned) that can be derived from subsidisation of school trips made by school children. For example, in addition to reducing travel money expenditure burden on parents and guardians of school children, the children will enjoy relatively comfortable ride as other patrons. In addition, those who could not afford the unsubsidised fare can now take advantage of the subsidised fare and not face the discomfort faced before, in having to lap each other in order to pay the going fare, or pay half the going fare to seat on what are called "attachments." The latter is not only to their own discomfort but also to the discomfort of full fare paying adult passengers who seat near them in such public transport vehicles as minibuses.

The presentation herein continues with a brief description of the original formula. This is followed by the steps and logic of the modification, which is done first to cater for school children (an imperative exercise) and then to cater additionally for the elderly (an optional exercise). Next, an example of the application of the modified formula is presented, before ending up the paper with a conclusion.

THE ORIGINAL SUBSIDISATION FORMULA

The original formula, tagged "commuter travel expenditure-income ratio method," belongs to the equity family, as opposed to the economic efficiency-based subsidy estimation methods which were proved to be inherently inappropriate for developing country settings in Osula (1988a) because they do not satisfy the desirable social service theme of public transport subsidisation in developing countries. The basic parts of the procedure are presented here while details of the logic behind its formulation are to be found in Osula (1998a).

The subsidisation estimation procedure, which uses the current level of personal transport allowance given to workers and the productivity of the transport service concerned, entails first ascertaining if subsidy is required. This is done by estimating an average transport expenditure-income ratio, R, for the working class trip makers that use the transport service, and comparing with a reasonable transport expenditure income ratio, R_R, which is considered to be the average transport allowance-gross income ratio.

Letting $R_i = f(I_i)$ be the function that relates transport expenditure-income ratio to income (inversely as noted earlier), R is obtained by dividing the area under the curve formed by this relationship by the income range as:

(1)

where i is the ith income group, I_i the average income of the ith income group and n the total number of income groups.

If R is equal to or less than R_R, subsidy is not required and the subsidisation estimation exercise does not need to continue. If on the other hand R is greater than R_R then subsidy seems required, and the estimation of the subsidy required in the next stage starts with obtaining an average fare, F_R, that corresponds to R_R. It is called average fare and not reasonable fare as would have been expected because the subsidy is being estimated for the average commuter, i.e, estimation is based on what the average commuter should pay after subsidy.

F_R is estimated simply by equating the transport services revenue (based on this average fare), realised from all daily trips made by the working class commuters using the transport service, to the daily transport expenditure (based on the reasonable transport expenditure income ratio) on all trips incurred by the same class of commuters as:

(2a)

For a simplified linear relationship, this equation may be written as:

(2b)

where N_i is the number of commuters in income group i, and T_W the total daily units of transport service (expressed as passenger-kilometers) consumed by workers. The estimation of F_R is based on daily trips made by working class commuters (i.e. regular office or site workers with regular incomes) alone because it is for this group of commuters that R_R can readily be obtained.

Where only average values of data are available, e.g. average worker daily income I, equation (2b) can be expressed as:

$$F_R \times T_W = R_R \times N \times I \qquad (2c)$$

where N is the total number of worker commuters using the transport service, i.e. the summation of N_i over the interval i = 1 to i = n.

The total subsidy requirement is being established as the excess of the actual fare, F_A, over this average fare, F_R, or an estimated profit fare, F_P (based on a reasonable profit margin). In a deregulated transport market (free market) or poorly regulated market, the actual fare is fixed by the operators, while in a regulated market, it is fixed by government as profit fare. It is thus expected that a regulated market will attract lower subsidy than a deregulated one.

The next stage is the estimation of the maximum and maximum levels of subsidy, S_{min} and S_{max} respectively, between which the actual subsidy, S will lie. It is to be noted that in a deregulated market, subsidy is required if $F_R<F_P<F_A$ and $F_P<F_R<F_A$, but not required if $F_R>F_P>F_A$ and $F_P>F_R>F_A$. For regulated market, subsidy is required if $F_R<F_A=F_P$ and not required if $F_R>F_P$. Thus S_{min} and S_{max} are estimated as follows:

Deregulated market: for $F_P<F_R<F_A$

$$S_{min} = F_A - F_R \quad (3a)$$

$$S_{max} = F_A - F_P \quad (3b)$$

and for $F_R<F_P<F_A$

$$S_{min} = F_A - F_P \quad (3c)$$

$$S_{max} = F_A - F_R \quad (3d)$$

Regulated market: equations (3c) and (3d) are operative since the condition for subsidy is $F_R<F_A=F_P$.

The presuppositions that gave rise to equations (3a and 3d) are that (i) in a deregulated or poorly regulated market, the actual fare charged is higher than the fare at reasonable profit (i.e $F_A>F_P$, because of the desire of operators to make high profits, and (ii) in a regulated market, the actual fare equals the profit fare (i.e., $F_A = F_P$) because fare is fixed by government.

S_{min} can assume a value of zero in equation (3c) if $F_A = F_P$, as is expected to always be the case for regulated market, and occasionally for deregulated market.

The actual subsidy, S, is obtained as

$$S = S_{min} + (S_{max} - S_{min}) (L - 0.5)/0.5 \quad (4)$$

where L is the load factor of the transport service. It is measured as the ratio of the passenger-kilometre per day to the product of the vehicle rated seating capacity and the total distance travelled by the transport service. The maximum and minimum values of L recommended are 1.0 and 0.5, respectively. The reader is referred to Osula (1998a) for the choice of these values.

Finally, the subsidised fare, F_S (for both regulated and deregulated markets) is obtained as:

$$F_S = F_A - S \tag{5}$$

The amount to be given as subsidy is the product of S and the appropriate daily, monthly, or annual productivity measure of the transport service.

An example of the use of this subsidization formula is presented in Osula (1998a).

MODIFICATIONS PROPOSED

In developing the modifications, the presupposition is that school trips are plentiful enough in Nigerian cities to make it imperative to cater for school children in the consideration of public transport subsidisation estimation, while it is only conditional upon an affirmative answer being obtained in regard to whether subsidy is required or not separately for middle-aged and elderly trip makers. This being the case, it is considered appropriate to estimate subsidy separately for these three category of trip makers. The first stage in the estimation process, therefore, is to obtain the proportions of the contributions of the three categories of trip makers to the total productivity of the transport service concerned.

Let T be the total productivity of the transport service. Let the proportion of school children and elderly trips to T be α and β, respectively, where α and β are both less than unity. Then the contribution of middle aged trips is $T(1 - \alpha - \beta)$. Those for school children trips and elderly trips are αT and βT, respectively. With these data known, the estimation of the subsidisation requirements for the three categories then follows as described in the remaining part of this section.

Middle-aged Trip Makers: With all other required data available for use in the original procedure described in the previous section, the equations are employed in obtaining the subsidy, but with T_W replaced with $T(1 - \alpha - \beta)$.

Elderly Trip Makers: With the appropriate data (same nomenclature but different values from those for middle aged trip makers), the same equations are employed for obtaining the subsidy, but with βT substituted for T_W. However, R_R obtained for the middle-aged category is used for this elderly category. This is to ensure that the subsidy level for the elderly trip makers will be higher than for the middle-aged trip makers. The former, as pensioners, earn less incomes (their pensions) than the latter.

School Children Trip Makers: For the purpose of transport subsidisation estimation, it is here considered that school children do not earn any regular income. For this reason, R and R_R cannot be estimated. Thus some form of rule-of-the-thumb procedure may need to be adopted in estimating subsidy for this category of trip makers.

With their own contribution to the total productivity being αT, if it is decided through some negotiations with public transport operators that school children's fare should be reduced by some proportion, λ, of the actual fare, F_A (actual fare for middled-aged trip makers), the subsidised fare for school trips made by school children will be $F_A(1-\lambda)$. The fare subsidy is λF_A while the amount of subsidy is $\lambda\alpha TF$. Fixing or negotiating λ may not be a problem if no subsidies are required for middle-aged and elderly trip makers. If fares are subsidised for both the middle aged and the elderly trip makers or for only the elderly trip makers, λ should be fixed such that subsidy for trips by school children should be higher than for the elderly (since subsidy for the elderly should normally work out to be higher than for the middle-aged).

While λ will adopt a value to be fixed through negotiation, as stated above, it is to be noted that in some cities in Nigeria where public transport operators give consideration to school children on their own, the value is 0.5, i.e., half the going fare for adults is charged for school children in uniform. This is reported to also be the case in Kingston, Jamaica (Heraty, 1980), where subsidy is given as a matter of course for school children and has been known to be given to the tune of 66 per cent for this category of public transport trip makers.

SUMMATION OF SUBSIDY COMPONENTS

Based on the modification proposed above, the fare subsidy, subsidised fare, and amount of subsidy for each category of trip makers are as in Table 1.

TABLE 1. Subsidy components and their summations.

Category of trip makers	Fare subsidy	Subsidised fare	Amount of subsidy
Middle-aged adults	S_M	$F_A - S_M$	$S_M T(1-\alpha-\beta)$
Elderly	S_E	$F_A - S_E$	$S_E \beta T$
School children	$S_{SC}=\lambda F_A$	$(1-\lambda)F_A$	$S_{SC}\alpha T$

The total amount of subsidy to be given for the transport service is the summation of the subsidy components (the fourth column of Table 1) as;

$$A = S_M T(1-\alpha-\beta) + S_E\beta T + S_{SC}\alpha T \qquad (6)$$

This is the upper extreme case, i.e, subsidy required for all three categories of patrons. Where the subsidisation formula yields subsidy for only middle-aged trip makers, equation (6) reduces to

$$A = S_M T(1-\alpha-\beta) + S_{SC}\alpha T \qquad (7)$$

This case is, however, not expected to occur since as stated earlier, the formula will usually yield a higher subsidy for the elderly than for the middle-aged trip maker.

Where the subsidisation formula yields subsidy for only elderly trips makers, equation (6) reduces to

$$A= S_E\beta T + S_{SC}\alpha T \qquad (8)$$

For the lower extreme, where subsidy is required for only school trips by school children (i.e., subsidy formula returns the verdict of no subsidy required for both middle-aged and elderly trip makers), equation (6) reduces to

$$A= S_{SC}\alpha T \qquad (9)$$

_This is so because as mentioned earlier, it is presupposed that school trips made by school children will always be subsidised. Thus, this component appears in all the four cases. Another presupposition, implicit in the argument given for the estimation of subsidy for the elderly, is that subsidy for the elderly is less than for school children but equal to or greater than for middle-aged adults, i.e., $S_{SC}>S_E$³S_M. Thus if it works out that $S_E<S_M$, then $S_E=S_M$ should be adopted.

The correctness of the formulation in this paper can be tested by adding the total subsidy to the revenue based on subsidised fare. It will be seen that in all the cases (equations 6 to 9), the result is the total revenue, i.e. TF_A.

EXAMPLE OF THE USE OF MODIFIED FORMULA

The example used to demostrate the application of the earlier subsidisation formula is extended here, with appropriate data added to reflect the three categories of patrons considered in the presentation. The transport market remains a deregulated one. The data are as follows;

Number of minibuses in operation daily = 350

Daily units of transport service incurred by workers, T\S\do3(W) = 79,272

Number of workers patronising the service daily = 14,413

Daily work trip rate = 2.24

Load factor, L = 0.83

Daily cost of operation per minibus = \O(N,=)114.26

Daily passenger-trips by the transport service, T = 161,424

Profit fare per passenger-trip, F\S\do3(P) = \O(N,=)0.3292

Actual fare per passenger-trip, F\S\do3(A) =
\O(N,=)0.5000

Proportion of trips by school children of daily passenger-trips, α =0.309

Proportion of trips by the elderly of daily passenger-trips, β =0.20

Average transport expenditure-income ratio for the middle-aged =0.12

Average transport expenditure-income ratio for the elderly =0.15

Ratio of average transport allowance to gross income, R_R =0.08

Number of elderly patronising service =6012

Average monthly gross income of working class (middle-aged) commuter =₦560.00

Average monthly gross income of elderly commuter =₦300.00

₦ is the Nigerian national currency, the Naira. As at the time (1989)of data collection for the example transport service, it exchanged at a rate of $1.00 (USA) to ₦7.6252.

The use of the data for the middle-aged trip makers in the formula yielded a subsidy of S_M=₦0.14 per passenger-trip and a subsidised fare of $F_S = F_A - S_M$ =₦0.36. (See Osula (1998b). Note that the notations introduced in the present paper to distinguish between the three categories of patrons have been used to replace the old ones in the previous paper.

For the case of elderly commuters, that R=0.15 is greater than R_R=0.08 suggests also that subsidy seems required to ease their travel expenditure burden. With an average gross income of I=₦10.00 per day (i.e., ₦300.00 per month), F_R works out using equation (2c) as;

F_R = ₦(0.15 x 6012 x 10.00)/(0.20 x 161424) =₦0.28 per passenger-trip.

This is the fare that the average elderly commuter is expected to pay for a trip. Since it is less than the actual fare, subsidy is confirmed required. Incidentally, it is also less than the profit fare. Hence for a deregulated market the minimum and maximum subsidies work out to be ₦0.17 and ₦0.22 per passenger-trip, respectively (equations (3c) and (3d)). Using equation (4), the fare subsidy required works out to be S_E=₦0.20. The subsidised fare for this category of patrons works out using equation (5) as $F_S = F_A - S_E$ = ₦0.30 per passenger trip.

Apart from the fact that calculations have yielded fare subsidies for both elderly and middle-aged categories of commuters, that for the elderly has come out higher than that of the middle-aged. Thus a fare subsidy lower than (or at least equal to) that for the elderly trip makers should be negotiated for school trips make by school children. A λ value of 0.5 could be targetted in this case. This will bring the subsidised fare for school trips to ₦0.25 per passenger trip, i.e., $(1-\lambda)F_A$. The subsidy is also equal to this value, but estimated using λF_A.

This subsidisation situation just considered is the upper extreme in which the total amount of subsidy is obtained by using equation (6). This total amount works out to be about ₦30,022.00. This is the amount to be given daily as subsidy to minibus transport service operators in the city. This amount is ₦7,422.00 higher than when the subsidisation estimation was based on only one category of patrons.

CONCLUSION

The foregoing has been an exercise carried out to modify an earlier general formula for estimation public transport subsidisation requirements for use in developing countries. The modifications have been made to cater for school trips made by school children as well as trips made by the elderly in the society. While it has not really been considered necessary to make a formal case for the subsidisation of school trips by school children, that for the elderly in the society has resulted from a recent finding to the effect that this group of people in Nigeria seemed to have been the most affected by the October 1994 fuel price increase, through increased travel money expenditure burden.

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