The Role of Wealth in the Demand for International Air Travel

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1. Introduction

In the past twenty years research on demand for air travel has generated much interest among scholars specialising in transport economics. A few notable studies are: Brown and Watkins (1968); DeVany (1974); Jung and Fuji (1976); Mutti and Murai (1977); Straszheim (1978); Anderson and Kraus (1981); Ippolito (1981); Haitovsky, Salomon and Silman (1987); and Meyer and Oster (1987). A major purpose of these and other studies has been to clarify and quantify the relevance and significance of the many dimensions characterising this unconventional good. Indeed, the quest was successful in providing information on the multifaceted role played by variables such as price, income, quality of service, distance of travel, value of time, security, price of other transport services, and more.

Research on demand for international air travel has been considerably less ambitious, focusing primarily on price and income elasticities. As a result, our knowledge of many analogous aspects of international air travel is relatively meagre. An important dimension which is missing altogether both from domestic and international air travel demand studies has to do with the way income is represented in those studies. Specifically, measures of income employed in all studies conform, to a greater or lesser degree, to the notion of current income. This practice, however, is at odds with economic theory which suggests that permanent rather than current income is the relevant variable which determines demand. The practice is also at odds with many empirical studies which successfully estimate demand for various durable and non-durable goods utilising various measures of wealth.

This criticism is prima facie supported by findings from time-series studies of air travel demand which show that serial auto-correlations in the errors term are pervasive and widespread. Such findings indicate that models estimated in the literature may indeed be mis-specified. In this paper we posit that a major source of mis-specification is the omission of variables representing consumers' wealth. Hence, inclusion of these variables may alleviate the problem.

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The purpose of this study is twofold. First, we seek to remedy the current situation and investigate the role played by consumers' assets in determining international air travel demand from Israel. It is hoped that our study will generate increased awareness of this apparent oversight and will foster the additional studies necessary for establishing the role of wealth in air travel demand. Second, we seek to verify whether estimates of price and income elasticities of international air travel demand by residents of Israel are any different in their magnitude from analogous estimates obtained for other Western countries. The latter are derived in Mutti and Murai (1977) who report on two outstanding results, namely, that income elasticity is significantly higher than one, and that price elasticity is lower than one for all six Western countries included in their sample.

The results obtained in the subsequent analysis are extremely encouraging. They allow us to confirm that demand for air travel out of Israel is price-inelastic and income-elastic. Price elasticity is found to be approximately –0.27, while income elasticity is between 1.64 and 2.06. These findings are in full agreement with those reported by Mutti and Murai (1977) for five European countries. More importantly, the results lend support to the fundamental hypothesis that consumers' assets are important determinants of international air travel from Israel. Variables representing consumers' wealth are completely overlooked in empirical studies in the literature; thus the above findings constitute an important contribution from the present study and deserve further attention and verification.

Finally, following the traditional literature we further estimated the demand by using a mis-specified model from which financial and non-financial assets are omitted altogether. The results obtained confirm our expectations regarding the impact of such omissions. The OLS estimates of price elasticity obtained are biased downward while the estimates of income elasticity are biased upward. In contrast, ML estimates of price elasticity and income elasticity are in line with those derived with the complete model. However, the explanatory power as well as standard errors of the estimates are considerably lower for the ML estimates than they are for the complete model which includes wealth variables.

2. A Time-Series Model of Air Travel Demand

Empirical research on airline travel demand has overwhelmingly employed cross-section data from city pairs. This practice is very useful in securing large samples which are essential for studying certain dimensions of consumers' travel demand such as value of travel time, value of waiting time, quality of service, security, and so on. It is also indispensable in studying the modal choice behaviour of consumers. Unfortunately, it does not permit accurate estimation of price and income elasticities since cross-section data exhibit relatively little variability in air fares per unit of distance. Being particularly interested in price and income elasticities, we must therefore employ aggregate time-series data which should permit simple estimation of the impact of price and income on air travel out of Israel.

Economic theory maintains that in equilibrium consumers' demand is a function of income and prices of all goods. Various scholars found it particularly advantageous to use specifications where demand for air travel was a function of all or some of the following variables: air fare; price of alternative modes; quality of service provided; current income; and price of complementary goods consumed while travelling abroad. A comprehensive model would preferably include all these variables. However, data problems on system-wide quality of service and sample size constrain the number of variables which can be included.

The preceding discussion and the conventional wisdom on temporal demand for international air travel suggest that an appropriate specification of this demand, which is also simple enough to permit estimation, can be written as:

$$D_t = f(P_t, I_t, PI_t) \tag{1}$$

where: t is a time index ($t = 1 \ldots T$); D_t is a measure of yearly travel volume; P_t is a measure of costs of the air travel; I_t is a measure of income; and PI_t is a measure of price of domestic goods which compete for income. Equation (1) is a static formulation of the model. Dynamic formulation requires a complicated specification of a lag structure; a task which is beyond the scope of this paper.

There is little theoretical basis for choosing among alternative forms of (1). However, the log-linear form has overwhelmingly been preferred and employed successfully in previous studies and will also be employed in the present study. Estimates of elasticities are therefore obtained as coefficients of the estimated equation:

$$\ln D_t = \alpha_0 + \alpha_1 \ln P_t + \alpha_2 \ln I_t + \alpha_3 \ln PI_t + u_t \tag{2}$$

where: α_i are elasticities and u_t is an error term with the usual statistical properties.

Economic theory maintains that a proportional change in money income and all prices must leave passenger demand unchanged. This condition can duly be incorporated in the demand function (2) by imposing the constraint $\alpha_1 + \alpha_2 + \alpha_3 = 0$. Incorporating this constraint into (2) we obtain:

$$\ln D_t = \alpha_0 + \alpha_1 \ln(P_t/PI_t) + \alpha_2 \ln(I_t/PI_t) + u_t \tag{3}$$

which gives us total demand as a function of real prices of travel and real income. Equation (3) is the basic form utilised in this study. Other attempted versions included one or more additional explanatory variables representing other factors deemed important in affecting consumers' propensity to travel. These factors were mainly macroeconomic variables such as percentage change in CPI, public employees, percentage change in GDP, family size and per capita import and export. Unfortunately, when these variables were included their coefficients turned out insignificant and therefore they will not be discussed here.

In implementing (3), several methodological issues and data problems arise which deserve attention. First there is a question concerning the best way to represent air travel demand. Many scholars find it appropriate to employ a simple measure of total passenger volume as their dependent variable. This choice, however, is not without weaknesses. Principally, it requires that the set of explanatory variables also includes a variable representing the size of population. In time-series analysis, where the number of observations is inherently small, adding population as an explanatory variable is unwar-

ranted as it leads to a loss of one degree of freedom and concomitantly increases the likelihood of multicollinearity. One way to avoid this problem is to define the dependent variable as a ratio of passenger volume to population. This variable is readily interpreted as a probability that a representative individual will travel by air in a given year. Alternatively, it can also be interpreted as the proportion of people who will travel by air each year.

In principle, the estimation of equation (3) requires data on prices of complementary goods consumed in numerous destination countries. Normally, such data are hard to come by and scholars have been forced to use the CPI in destination countries instead. Fortunately, we are in a better position. Consumers' expenses on travel abroad by residents of Israel are substantial, and as a result air travel expenditure is included as one component of the general CPI in Israel. This component, calculated by the Central Bureau of Statistics on a monthly basis, takes into consideration both air fares and the costs of other complementary goods paid for in Israel through travel agents and consumed by travellers during their trips abroad. Thus, the price index employed in our empirical estimation makes up both air fares and complementary goods and, not accounting for the value of time, is accordingly interpreted as the full price of travel. This measure should therefore be distinguished from the price variable used by Mutti and Murai (1977) which is restricted solely to air fare.

Finally, the role played by income is depicted in our model by three distinct variables: current income and two variables representing consumers' wealth. In accordance with the general theme of the paper we posit that an aggregate income variable which combines income from different sources may be inadequate, since propensity to travel may be different according to the source of income. Allowing consumers' income to be represented by three distinct components is advantageous, since it does not restrict *a priori* the elasticities of wage income, income from financial assets, and income from non-financial assets to be identical.

The current income variable used in this study is real average wage per employee, as reported by Israel's National Social Security Administration. In general, this variable leaves much to be desired since it does not include current income by self-employed people. However, as we use time-series data where the share of current income by employees and the self-employed does not change much through time, such an omission will not affect the estimated parameters. It may affect the estimates if unemployment is changing over the time period. It is of note that this variable is different from income variables used in the literature which refer to GDP or disposable income. This variable, however, is most suitable for our purpose as non-wage income is represented by wealth variables.

Consumers' wealth is represented in our study by the pair *per capita non-financial assets* and *per capita financial assets*. The former consist mainly of housing, machinery and equipment, durable goods and stocks of physical inputs, while the latter consist of retirement funds, long-term saving deposits, bonds, shares, other deposits and cash. This distinction may be important since the two differ in their respective degrees of liquidity. If liquidity is not an important feature that affects travel demand we would expect that the

coefficients of these two variables will be positive and of the same order of magnitude. If, on the other hand, the propensity to travel is also affected by the liquidity of assets, we can expect that elasticity with respect to financial assets will be greater than elasticity with respect to non-financial assets.

The preceding discussion suggests that the general model to be estimated is:

$$\ln D_t = \alpha_0 + \alpha_1 \ln(P_t/PI_t) + \beta_0 \ln(W_t/PI_t) + \beta_1 \ln(FA_t/PI_t) + \beta_2 \ln(NFA_t/PI_t) + u_t \quad (4)$$

where: D_t is the ratio of number of travellers by air to population; P_t is the full price of travel; FA_t is financial assets; NFA_t is non-financial assets; W_t is wage per employee; PI_t is the CPI; and β_0, β_1 and β_2 are elasticities with respect to $W_t FA$ and NFA.

3. Empirical Analysis

The regression analysis of our model was based on yearly observations for the period 1970 to 1989 for which data on all the variables are available. The estimation and analysis of aggregate air travel demand equation (4) require the use of time-series data on number of travellers, population, full price of travel, income, financial assets, non-financial assets and CPI. Data on the number of residents' departures by air from Israel to all foreign destinations are obtained from various *Statistical Abstracts of Israel*. These figures are based on actual enumeration of departing citizens made in accordance with the law at points of departure. One limitation of this measure is that it also includes citizens who, at the time of departure, were either not residents of Israel or were residents migrating out of the country. Their inclusion presents a problem since our model is not designed to explain their demand. To meet this problem and limit the analysis only to residents of Israel the dependent variable is constructed as total departures of citizens less the number of citizens who did not return to Israel within the following year.

Statistical Abstracts of Israel were also used to obtain data on population, current income, and CPI. Except for the income series, which was discussed above, the remaining data present no major problem which requires further elaboration. Data on the full price of travel were obtained from *Monthly Price Statistics* published by the Central Bureau of Statistics. These publications display a price index for travel abroad which is a component of the general CPI. Finally, data on total assets and their breakdown into financial and non-financial assets are taken from *Yearly Reports* of the Central Bank of Israel. As such they are as reliable as possible and present no major problem.

Table 1 displays results obtained for several versions of equation (4) with the dependent variable being per capita travel volume. It should be noted that in dividing passenger volume by population we are actually assuming a unitary population elasticity with respect to total demand. The validity of this assumption can be tested by running a regression where the dependent variable is total volume and the set of explanatory variables includes a population variable. The results of this regression, which confirm the above presumption, are given by:

$$\ln D_t = 7.77 - 0.28 \ln P_t + 1.61 \ln W_t + 0.83 \ln TA_t + 1.07 \ln POP_t$$
$$(3.13) \quad (2.26) \quad (5.20) \quad (4.80) \quad (2.07) \quad (5)$$
$$\bar{R} = 0.989 \quad F = 421.34 \quad D.W. = 1.80 \quad t_{\alpha_{POP}=1} = 0.13$$

Table 1

Demand Elasticities for Air Travel from Israel
(t-statistics in parentheses)

Explanatory Variables	*1*	*2*	*3*	*4*
Constant	–10.89	–7.24	–7.47	–7.03
	(8.75)	(3.02)	(9.19)	(3.24)
P	–0.26	–0.34	–0.28	–0.29
	(2.04)	(2.46)	(2.32)	(2.19)
W	2.06	1.55	1.64	1.58
	(12.60)	(3.74)	(8.59)	(4.33)
NFA	0.56	0.72	-	-
	(2.83)	(3.18)		
FA	0.38	0.24	-	-
	(3.28)	(1.55)		
TA	-	-	0.85	0.84
			(6.41)	(5.70)
T	-	0.02	-	0.002
		(1.34)		(0.22)
$\bar{R}^2$	0.982	0.982	0.984	0.983
D.W.	1.95	1.49	1.82	1.77
F	252.93	213.65	378.96	267.33
$t_{\alpha_3 = \alpha_4}$	0.63	1.36	-	-

On the whole, the results displayed in Table 1 are remarkably encouraging and they allow us to confirm the main hypotheses of the paper. As expected in time-series analysis, the R^2s are rather high, clustering around 0.983. Less expected, yet very reassuring, is the finding that all the Durbin-Watson statistics presented in equation (5) and Table 1 show that serial correlation among error terms does not appear to be a problem in our models. This finding is at odds with Mutti and Murai (1977), Straszheim (1978) and Meyer and Oster (1987) and others, who all found that serial correlation was a serious problem in their studies. We will explore this issue in more detail later and attempt to show that the different findings are not really at odds and can be reconciled.

It can readily be verified from Table 1 that, regardless of the specification used, income elasticity is greater than one, price elasticity is smaller than one, and both are highly significant. This finding is robust and does not change when additional variables are

added. The results thus provide support for the general postulate that international travel is a luxury good with an income elasticity greater than one and is inelastic in full price. Such a relation has previously been confirmed by Mutti and Murai (1977) for several countries including the United Kingdom, the Netherlands, Italy, Germany, France and the US, and by Ippolito (1981) for the US, and it is hereby also confirmed for Israel. Price elasticity is found to range between –0.26 and –0.34, depending on the particular specification chosen. This elasticity, in absolute value, is lower than those found for the US and Italy, is of the same numerical order as those found for the UK and the Netherlands, and is greater than those of Germany and France. However, whereas elasticity is highly significant for Israel it is not for many of these countries. Price may not affect travel demand in the UK, the Netherlands, Germany and France, but definitely affects travel demand in Israel.

Second, price elasticities reported here and in Mutti and Murai (1977) are not fully comparable since different price definitions are used in the two studies. Specifically, the definition adopted by Mutti and Murai (1977) refers only to air fare, whereas ours is much broader and includes other components of the cost of complementary goods consumed abroad while travelling. The estimated current wage income elasticity ranges between 1.55 and 2.06 depending on the specification chosen. This is in agreement with Mutti and Murai (1977) who found that income elasticity for air travel on the North Atlantic ranges between a low of 1.77 and a high of 4.38 for various European countries and the US.

We now turn to the principal innovation of this paper, namely, the analysis of the role played by variables representing consumers' wealth. As Table 1 shows, except for *FA* in column 2 which is insignificant because of multicollinearity with the trend variable, wealth variables display the anticipated positive signs and are highly significant. The trend variable, customary in most time-series studies, is not significant. The results therefore provide solid support for the fundamental hypothesis that demand for international air travel is determined, other things being equal, by consumers' wealth. For reasons that are not fully understood, earlier studies ignore wealth variables in their analyses. Hence, if our findings are indicative, previous studies cannot fully account for air travel demand and, even more seriously, estimates of demand elasticities obtained in such studies may be biased because of this omission.

Demand elasticity with respect to non-financial assets (*NFA*) is found to be 0.72 in an equation which includes a trend variable and 0.56 in an equation which does not include it. Likewise, elasticity with respect to financial assets (*FA*) is found to be 0.24 in the former equation and 0.36 in the latter. It is therefore the case that regardless of the specification employed, demand is inelastic both with respect to financial and non-financial assets.

In comparing the magnitude of the elasticities of the two components of consumers' wealth, an argument can be advanced which renders benign the hypothesis that the elasticity with respect to financial assets should be greater than elasticity with respect to non-financial assets. The validity of such an argument hinges upon the perception that financial assets are more liquid than non-financial assets, and consumers show greater tendency to use liquid assets to finance relatively expensive travel. If, however, liquidity is not an important component promoting travel decisions the two elasticities should be

Table 2

Estimates of Demand Elasticities for Air Travel when Assets Variables are Omitted
(t-statistics in parentheses)

Explanatory Variables	*OLS*		*ML*		
	1	*2*	*3*	*4*	*5*
Constant	-8.19	-3.49	-1.05	-6.58	-10.33
	(5.56)	(0.98)	(1.44)	(8.49)	(8.87)
P	-0.42	-0.51	-0.28	-0.32	-0.28
	(1.98)	(2.34)	(1.03)	(2.50)	(2.21)
W	2.73	1.87	1.85	1.50	2.02
	(16.57)	(3.00)	(4.80)	(6.93)	(12.08)
NFA	-	-	-	-	0.62
					(3.05)
FA	-	-	-	-	0.43
					(3.49)
TA	-	-	-	1.00	-
				(5.90)	
T	-	0.02	-	-	-
		(1.59)			
$\bar{R}^2$	0.945	0.948	0.635	0.978	0.979
D.W.	1.15	0.91	2.57	2.11	2.10
F	163.28	116.30	16.64	264.42	208.01
ρ	-	-	0.74	0.10	0.00

similar, in which case it is total assets rather than individual components that affect travel demand. Equality of the two coefficients can also be justified in our case by realising that over 65 per cent of financial assets consist of non-liquid retirement and life insurance policies and long-term saving schemes.

It can readily be verified that, contrary to the above logic, the point estimate of elasticity with respect to non-financial assets (*NFA*) turns out to be greater than the elasticity with respect to financial assets (*FA*) in all versions estimated. Thus our findings do not lend support to the former hypothesis. This observation notwithstanding, testing formally for equality of the two coefficients yields non-significant *t*-values, displayed in the final row of Table 1, and it is therefore concluded that they are not significantly different from each other. This lends support to the hypothesis that as far as travel demand is concerned it is

total assets and not separate components that are important. Table 1 displays the estimates obtained when *FA* and *NFA* are replaced by a variable representing total assets (*TA*). As expected, both the price and current income elasticities have not changed much and the coefficient of total assets is approximately the sum of the individual coefficients.

Having established the importance of total assets in determining demand for international air travel, an important issue which can be addressed at this juncture concerns the impact that an omission of this variable will exert on price and income elasticities. Such an omission will have no effect whatsoever on estimated parameters only if the covariance between included and excluded variables is zero. To gain insight into this issue and search for a possible explanation for the persistent autocorrelation reported in the literature, we display in Table 2 regression results derived when the demand equation is estimated by omitting all consumer-wealth variables. These equations are analogous to the ones used in almost all studies reported in the literature which do not include wealth variables. In our sample the correlation coefficient between price and financial assets is –0.3 and between price and non-financial assets is –0.35. These negative covariances explain the downward bias in the estimates of the price coefficient displayed in Table 2, column 1. The correlation coefficients between wage income and the two components of assets which are 0.5 and 0.8 explain the upward bias of the coefficients of wages.

Not surprisingly, a striking difference between the OLS results displayed in Table 2 and companion results displayed in Table 1 is that, in agreement with results reported in the literature, all the Durbin-Watson statistics in Table 2 are insignificant. This finding lends support to the view that exclusion of variables representing consumers' assets typically leads to mis-specification embedded and reflected in prevalence of serial correlation among errors. Alternatively such mis-specification may arise as a result of dynamic behaviour; in which case the missing component is the lag structure of the model. This possibility has not been investigated in the literature and will not be studied here. At any rate, the omission generates estimates which are biased and concomitantly their variances are unduly large. The approach adopted in the literature was to remedy autocorrelation by employing maximum likelihood (ML) estimation procedures for removal of autocorrelation. In general, this approach can duly overcome the problem generated by prevalence of a first order autoregressive error term but need not provide a satisfactory solution to omission of variables. Consequently, the estimates obtained in the literature may still be biased.

The estimates displayed in Table 1 can be used as a benchmark against which we can evaluate the extent of the bias involved using OLS. This can be accomplished by estimating mis-specified versions of our model from which variables representing consumers' assets are excluded using OLS and ML procedures. These estimates, which are comparable to those reported in most studies in the literature, are displayed in Table 2. Indeed, the results are revealing and provide important insights on the quality of estimates derived when wealth is not included in the model. A few observations are noteworthy. First, the estimates of price and income elasticities derived with the OLS are –0.42 and 2.73, respectively, compared with –0.26 and 2.06 obtained with wealth variables. It is the case that OLS price elasticity is biased downward while income

elasticity is biased upward. Second, ML estimates of price and income elasticities derived from the mis-specified model corrected for autoregressive terms are –0.28 and 1.85 respectively. These estimates are not different from those reported in Table 1 and thus, at least as far as Israel is concerned, the bias arising from omission of wealth variables is at most meagre. Third, the major shortcoming of employing ML estimation procedure is our inability to incorporate the role of wealth in the determination of air travel demand, as is evident by the relatively low $\bar{R}^2$ (0.635) and the unduly large standard errors of the estimates obtained. Whereas the coefficient of price is highly significant in Table 1 it is insignificant in column 3 of Table 2. If data on wealth had not been available one would have had no choice but to conclude erroneously, based on ML estimates, that price is not a significant factor affecting demand. Indeed, this is exactly the result obtained in Mutti and Murai (1977) who did not use wealth variables in their study. Notwithstanding these negative results, it is reassuring that the extent of the bias obtained with ML is meagre.

Finally, to test for significance of wealth variables in the demand for air travel we constructed an F-test based on an ML equation which includes wealth variables and one which does not include them. The F-value obtained for this test is 460.24, which reveals that financial as well as non-financial assets are indeed important variables affecting air travel demand.

4. Concluding Remarks

The study and modelling of demand for transport which has proliferated during the past two decades has enabled considerable expansion and improvement of our understanding of the many dimensions of air travel. A major limitation which still prevails and has not previously been addressed is the failure to include variables representing consumers' wealth in the estimated models. Such variables are tacit in demand models where the notion of permanent rather than current income is the appropriate factor affecting demand.

To remedy this neglect we have formulated and estimated an aggregated model of international air travel demand which includes variables representing consumers' wealth. The principal findings of the foregoing analysis can be summarised as follows. First, in agreement with previous studies, air travel from Israel to all foreign destinations is found to be highly elastic in income and inelastic in price. Second, the role played by variables representing consumers' wealth in affecting demand is firmly established. Contrary to common conjecture there is no difference in demand elasticity between financial and non-financial assets and both are shown to be inelastic. Finally, using OLS for estimating air travel demand and omitting variables representing consumers' wealth, yields price elasticities which are biased downward and income elasticities which are biased upward. In contrast, using ML estimation procedures for removal of autocorrelation appears satisfactory in yielding credible income and price elasticities. However, the standard errors of the estimates are unduly large and do not allow confirmation of hypotheses regarding the role of price. The inclusion of wealth variables eliminates serial correlation, corrects for the bias and improves the precision of the estimates.

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