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Disappearance of American Wealth and Its Impact on Air Travel: An Empirical Investigation

by Dipasis Bhadra

Recently, the Federal Reserve reported that U.S. households net worth dropped by $17 trillion, a stunning 26% loss from the peak of the cycle to the bottom. The precipitous drop in home and stock prices that continued through the first quarter of 2009 accelerated the drop in household wealth. Meanwhile, U.S. air travel suffered tremendously. While the economy contracted by around 1% in 2008 and the first part of 2009, total domestic enplanement dropped more than 4% over its 2007 level. Gross domestic product (GDP) or some other measure of current income has been a good predictor of air travel in the past. While current income is considered to be a good proxy for current discretionary spending, of which air travel is only one small part, recent destruction of wealth has significantly reduced the average consumer's traditional appetite for expenditure, including air travel. Interestingly, there is very little empirical analysis that establishes a link between wealth and air travel. The paper seeks to address this gap by asking and investigating two empirical questions: (a) Does wealth have any quantifiable impact on U.S. air travel, controlling for all other relevant variables such as current income, past wealth, fare, and credit availability? (b) What has been the quantitative impact of wealth loss on air travel? The paper finds that the household wealth loss of U.S. $17 trillion yielded a loss of air travel demand of 730,000 passengers; or a loss of revenue of $244 million. As household wealth improved during the last two years, air travel recovered. Some of the lost passenger demand has been recouped (435,000) but a complete wealth-induced recovery still seems to be far off. Results of this analysis are important for both understanding future transitions in U.S. air travel, and hence forecasting, and formulating policy responses that may be designed more narrowly and effectively.

INTRODUCTION

Much has been written on the meltdown of U.S. financial markets and the impact on household's net wealth or net worth.[1] At the height of the financial debacle, the average wealth of American families plunged over 26%, or by almost $17 trillion. This was the largest loss since the Federal Reserve began keeping track of U.S. household wealth since World War II. Virtually every economic indicator went down, thus creating the longest and deepest economic recession since the Great Depression. The reverberations of the Great Recession of 2007-2009 are still being felt in almost all sectors of the U.S. economy.

Interestingly, very little research has been done to understand how this massive change in household's portfolio of assets and wealth impacted the way households consume goods and services. While the drop in overall personal consumption expenditure (PCE) in response to the Great Recession has been noted, there has been very little research investigating the effect of wealth loss on the composition of PCE. In particular, there does not exist any theoretical or empirical research integrating wealth and its impact on U.S. domestic air travel.

Empirical relationships postulate positive relationship between current income and components of current consumption. Using the estimated relationships and assuming them constant over time, forecasters derive components of PCE given the forecasts of current income. A similar methodology is also employed in generating forecasts of air travel. Despite the empirical (Gournichas and Parker 2002) and theoretical (Ghez and Becker 1974) existence of life cycle consumption hypotheses, the influence of asset portfolios is generally ignored. Very little is known as to how wealth is used to smooth out fissures in current consumption as nominal income drops due to a contracting economy; or alternatively, current consumption is boosted due to the expansion of wealth-enhancing consumer confidence and providing relatively easy access to liquidity. In other words, asset holding has a significant influence on consumption patterns and overall standards of living. This point was captured succinctly by Alan Greenspan as following: "Ultimately, we are interested in the question of relative standards of living and economic well-being. We need to examine trends in the distribution of wealth, which, more fundamentally than earnings or income, represents a measure of the ability of households to consume." Former Chairman of the Federal Reserve Bank, 2008 (see http://www.federalreserve.gov/boarddocs/Speeches/1998/19980828.htm).

There appears to be two reasons for ignoring this relationship: First, asset portfolios have traditionally remained illiquid and have had relatively little impact on changes in consumption as a whole and air travel in particular; only in recent times, has part of the massive wealth expansion been made available for current consumption via easy liquidity. Second, it is difficult to forecast movements in asset portfolios, far more difficult than forecasting growth in current or nominal income over time. Thus, *apriori* knowledge of the empirical relationship between wealth and consumption as a whole and air travel in particular is not really useful because of the forecasters' restricted ability to predict movements in wealth.

This paper is designed to fill the void with respect to the former issue; that is, the relationship between assets and air travel is explored at some length in this paper. This paper seeks to demonstrate that the asset portfolio has become important as people began to take advantage of the liquidity of the asset portfolio, and increasingly more people retire over time. Second and more importantly, volatility in asset portfolios has had considerable influence over air travelers' behavior. Examining size and relative change in magnitude of wealth and its impact on air travel is the key empirical issue underlying this paper. The paper acknowledges the difficulty in forecasting wealth. Nevertheless, an alternative is sketched out toward the end of this paper strengthening the forecasting of air travel that incorporates both nominal income and movements in assets. By offering a somewhat simple and tractable empirical framework, the paper sheds some new light on the issues relating to forecasting, i.e., movements in assets and impact on air travel in the future.

The paper is organized as follows. The second section provides a brief discussion of the magnitude of losses (and more recently, gain) of total wealth and its impact on overall PCE and air travel. This section also reviews the available empirical literature on related issues. Borrowing from the macroeconomic literature, the third section provides an analytical framework linking wealth, current income, and air travel. This section lays out the key empirical hypotheses and introduces data and empirical structure. The next section provides the key empirical findings, and discusses the implications of these findings including forecasting. The last section explores future research, and policy implications and provides some concluding thoughts.

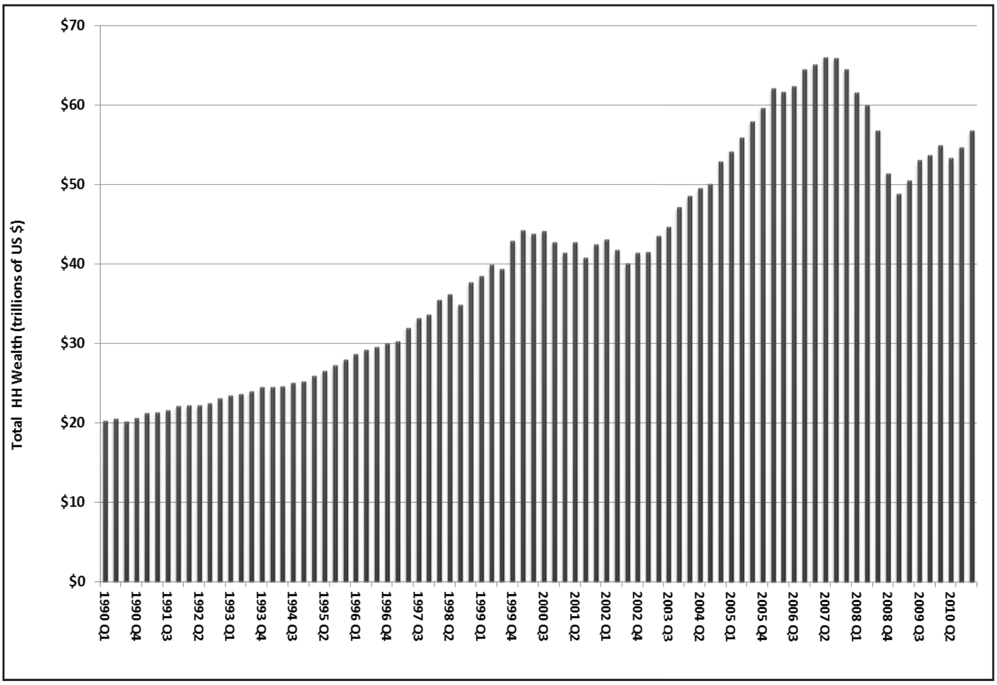
BACKGROUND

U.S. households experienced an extraordinary expansion in wealth (see Figure 1) over the last two decades. Not accounting for inflation, the value of U.S. households' wealth doubled in the decade of 1990s; from a total of $20 trillion in 1990 to over $43 trillion in 1999:Q4 (Figure 1).

Following an average growth rate of around 5% in the earlier part of the decade of 1990s (1990-1994), wealth began to expand rapidly in 1995 fueled by the tech boom that lasted until 2000:Q3. During this period, i.e., 1995:Q1 – 2000:Q3, the average rate of growth doubled to an annual return of 10% (see Figure 2).

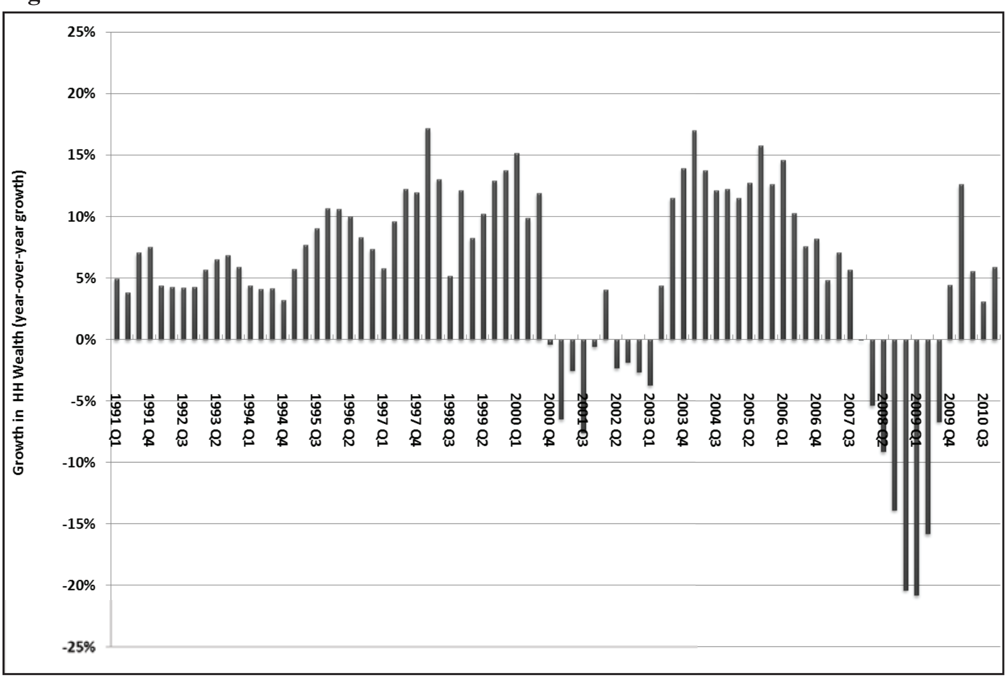
As the tech bubble burst, the wealth portfolio began to shrink at an annual average rate of -2% that lasted 10 quarters from 2000:Q4 to 2003:Q1 (see Figure 2). Interestingly, however, the economic recession during this period lasted only eight months from March, 2001 to November,

Figure 1: Trends in U.S. Households Total Wealth (Trillions of U.S. $)



Source: Based on data available at http://www.bea.gov/national/index.htm#gdp; and http://www.federalreserve.gov/releases/z1/Current/

Figure 2: Growth and Destruction of U.S. Households Wealth



Source: Based on data available at http://www.bea.gov/national/index.htm#gdp; and http://www.federalreserve.gov/releases/z1/Current/

2001. Nonetheless, the economic recession lasting a shorter period than the average duration has had a significant impact on the duration of wealth contraction.

The next phase in family wealth expansion began to take place as early as 2003:Q2. Rapid expansion in the housing market fueled the next round of wealth expansion that lasted 17 quarters during 2003:Q2–2007:Q3, generating over $22 trillion additional value and yielding an annual average rate of 11%. Like the prior period, additional wealth generated during this period found its way to liquidity via numerous types of secured and unsecured loans. Consumers responded to this additional liquidity by consuming more.

The financial crisis that accompanied the housing market crash continued during 2007:Q4–2009:Q3 and was extraordinary in both severity and effect. Over half of the earlier gains, $15 trillion (out of $22 trillion) at the bottom in 2009:Q2, was lost, recording an all-time average decline of 11% annually and was unprecedented compared to earlier declines, particularly to the one that was followed by the tech bubble deflation (i.e., -2%). This extraordinary contraction was possible due to an overall decline in home prices, which is still continuing in many major metro areas, and a decline in stock prices. However, despite the overall continuing fall in market price and thus, declining value of real estate, households' wealth portfolio began to expand again in 2009:Q4 and continues at an average rate of 6% annually. This was possible primarily due to the superior performance of the stock market. The stock market has had an extra ordinary performance run for almost six quarters; the performance has halted only recently following a devastating natural disaster in Japan in March 2011 and the European debt crisis.

The rise and fall in asset holdings demonstrate that while, in the long run, wealth tends to expand at around 5%-6% annually, the interim pace of returns appears to have become increasingly volatile, particularly during contraction. Second, and most importantly, the volatility may have behavioral consequences on the way households allocate finances and consume goods and services. These changes may have long-term implications on transitions of the economy.

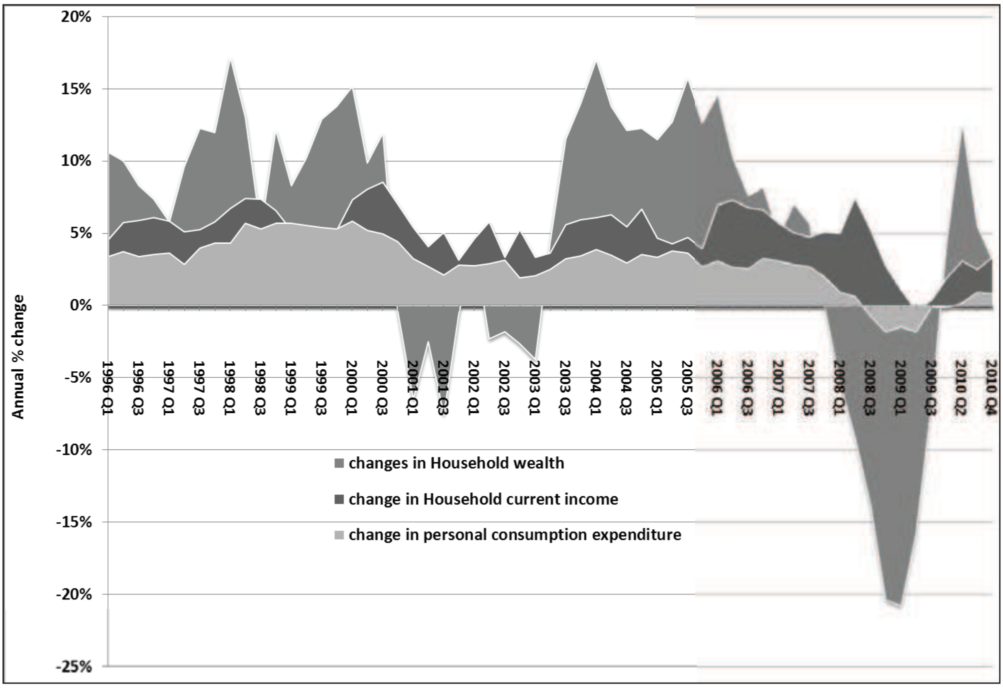
At the end of 2010, PCE in current dollars stood at around $10.35 trillion, or around 70% of gross domestic product (GDP) of $14.66 trillion in current dollars and $13.25 trillion in chained or constant dollars (see http://www.bea.gov/national/index.htm#gdp). In addition to a severe decline in returns to wealth holding, the severity of the Great Recession resulted in a contraction of PCE; the U.S. households' PCE shrank an annual average rate of 1% during 2008:Q3–2009:Q4 (see Figure 3).

Interestingly, PCE grew despite the earlier recession (2001) although the rate of growth slowed considerably to an average rate of 3% during the earlier part of the decade of 2000. The PCE grew at an average annual rate of 4.6% during the latter 1990s. Following the deep recession, PCE growth has turned positive only recently (2010:Q1) and now shows a little over 1% annual growth. It is worthwhile to note that, other than during the period of the Great Recession, the relationship between PCE and net worth is not easily evident.

This relationship is somewhat clearer as components of the PCE are considered. Not including expenditure on durable and non-durable goods (around $3.43 trillion), PCE for services stood at $6.7 trillion (or 64% of total PCE) in 2010. Households spent around 28% on housing/utility related expenditure ($1.69 trillion); a little over 25% on health care ($1.46 trillion); a little over 9% on food services ($626 billion); 4.5% on transportation services ($300 billion); 5.7% on recreation services ($381 billion); 12.3% on financial services and insurance ($821 billion); and 14% on other services ($942 billion).

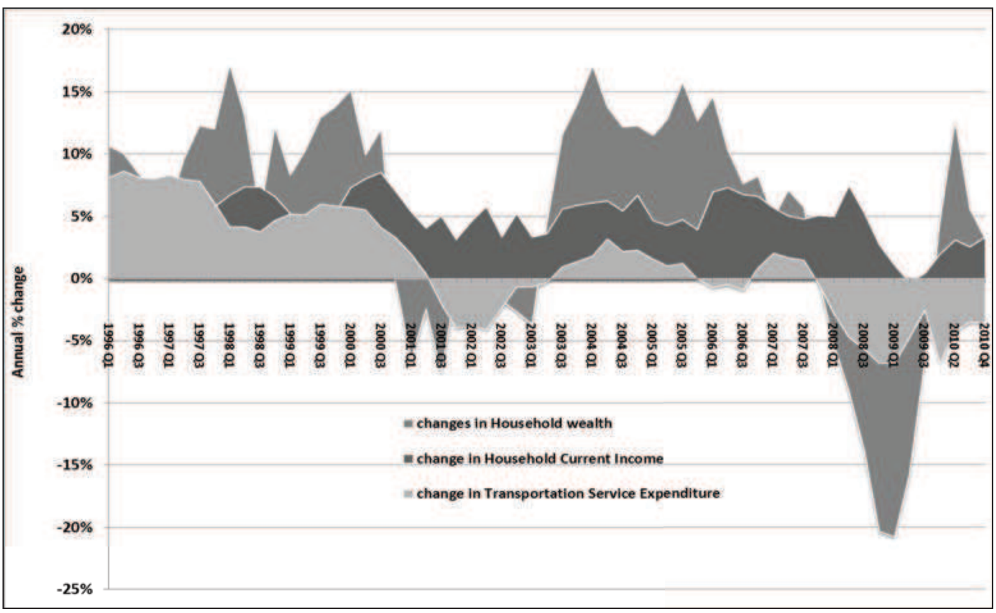
Aggregate household expenditure account does not identify air travel; instead, the expenditure can be indirectly calculated using expenditures on transportation and recreation services. Expenditure on air travel and related services is estimated[2] to be 2.1% of total PCE services, or $190 billion/year and assumed to be originated in expenditure on transportation and recreational services. Figure 4 illustrates the trends in expenditure on transportation services with respect to changes in household wealth and net income. As the figure shows, expenditure on transportation services has

Figure 3: Trends in U.S. Households Income, Net Wealth and PCE



Source: Based on data available at http://www.bea.gov/national/index.htm#gdp; and http://www.federalreserve.gov/releases/z1/Current/

Figure 4: Trends in Income, Wealth and Transportation Service Expenditure

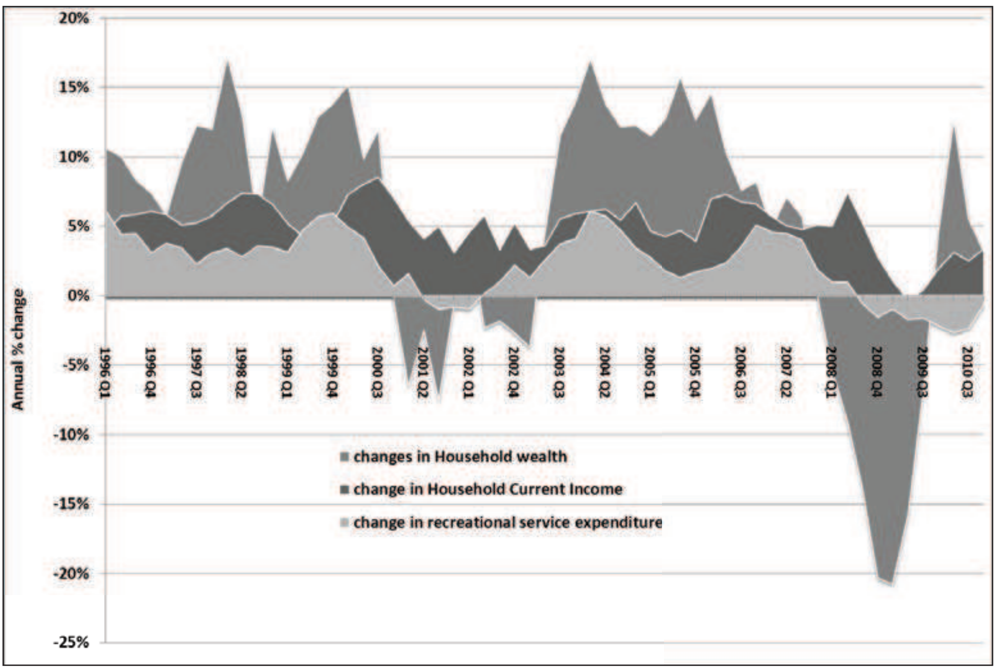


Source: Based on data available at http://www.bea.gov/national/index.htm#gdp; and http://www.federalreserve.gov/releases/z1/Current/

been relatively responsive to changes in economic conditions; as income and wealth contracted, households adjusted their spending by cutting down on transportation services and vice versa (see Figure 4).

In comparison, spending on recreational services adjusted downwards rather slowly as income and wealth went down but adjusted upward faster during the period of economic expansion, i.e., the decade of 2000 following 9/11 (see Figure 5).[3] An evaluation of the expenditure patterns reveals that expenditure contraction has been rather disproportionate for transportation and recreational services during the Great Recession: -5.6% (Figure 4) and -1.44% (Figure 5) respectively although PCE services declined "only" by 1% during the period 2008:Q3–2009:Q4. In other words, of the total unspent expenditure on PCE-Services of around \$92 billion for a year (-1%), a combined total of \$20 billion (or, 22%) had not been spent on transportation and recreational services in aggregate. Notice that this knowledge in aggregate does not allow us to decipher the amount lost in air travel during this period. The analysis presented later attempts to shed some lights on identifying this value.

Figure 5: Trends in Income, Wealth and Recreational Service Expenditure

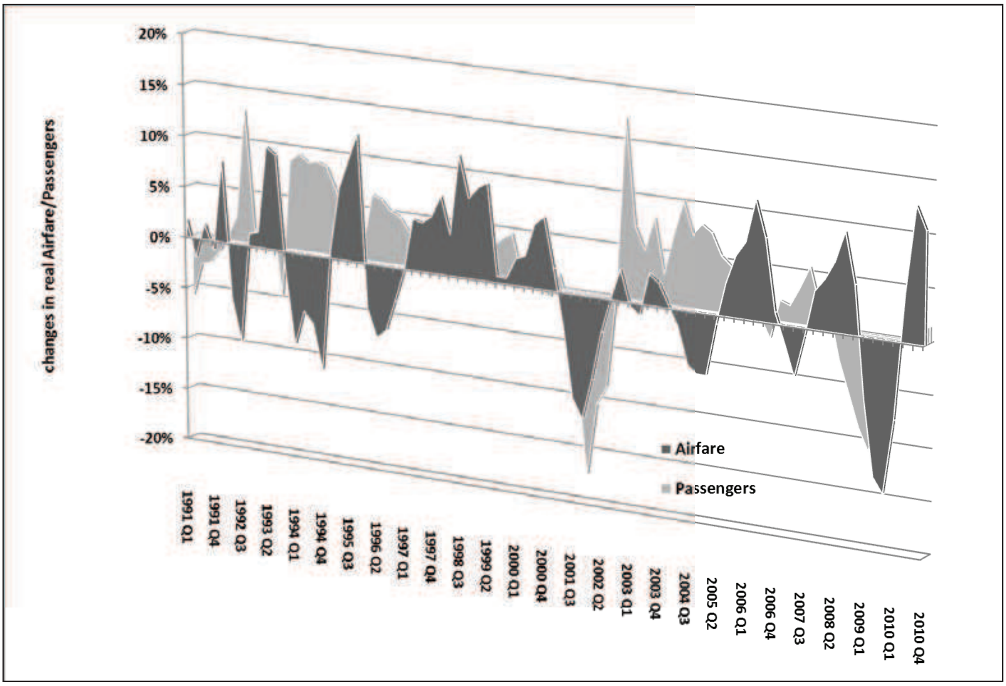


Source: Based on data available at http://www.bea.gov/national/index.htm#gdp; and http://www.federalreserve.gov/releases/z1/Current/

The above discussion appears to indicate that there may be a relationship between household wealth and spending on different components of consumption expenditures, particularly air travel given the focus of this paper. However, the causality of that relationship is not clearly evident, nor is it quantified and established in the empirical literature. Most empirical studies of domestic air travel do not take into account wealth (or any measure of permanent income) in estimation and/or forecasting. Most of the existing studies and forecasting framework employ some form of gravity framework (Bhadra 2003; Bhadra and Kee 2008) specified in terms of fare, economic activities (i.e., mostly, current income), demographics, distance, and seasonal variations. At the core of these empirical studies sits the negative relationship – observed and/or estimated - between fare and passenger demand. Figure 6 demonstrates this basic relationship: as airfare drops, generally speaking, passenger demand increases and vice versa. Positive co-movements, on the other hand, capture the essential responsiveness of passenger demand to changes in economic growth, such as GDP and/or personal income (Bhadra 2003 and Bhadra and Kee 2008).

However, when this negative relationship does not hold, e.g., periods of 1991, 2001–2002, and 2009–2010 in Figure 6, econometric modelers often use dummy or qualitative variables to capture the major structural shifts in the quantitative relationship (i.e., periods of economic recessions, 9/11, financial calamities). Interestingly, very little attention has been given to capture the underlying dynamics beyond the flow mechanics of price/fare, current income, and role of dummy variables to capture the movement in demand for air travel.

Figure 6: Trends in Air Fare and Passengers



Source: Based on data available at http://www.transtats.bts.gov/

LITERATURE REVIEW

In representative spirit of earlier empirical studies, Bhadra and Kee (2008) provided an analysis of the fundamental structures and dynamics of the origin-destination (O&D) or core air travel markets in the U.S. using quarterly data covering 1995–2006. Despite all the adversities, e.g., the industry gradually consolidating its network, SARS, internet pricing and availability of videoconferencing, jet fuel price hikes of summer 2008, and sustained capital drain via losses in the last decade - just to name a few, passenger flows between O&D markets have exhibited strong growth in recent years. When segmented by types of markets, Bhadra and Kee (2008) found that while super-thin markets (10 passengers or less a day) lost service, other market segments gained service over time. For example, a majority of passengers flying in the thick markets (more than 100 passengers a day) accounted for only a small portion of the markets, but demand continued to grow in those markets over time. Using fare and income elasticities (both origin and destination), Bhadra and Kee (2008) demonstrated that thick markets were structurally different than other types of markets.

Reviewing 23 key empirical studies covering the last quarter century, InterVistas (2007) concluded that the changes in air fares was the key factor in determining demand responses. The exact magnitude of the demand responses depended upon types of passengers (i.e., business vs. leisure passengers), distance of travel (short-haul vs. long-haul travel), carrier vs. market vs. national level responsiveness in demand changes (i.e., differentiated responses in traffic with respect to fares), and income elasticities. Using this review in the background, InterVistas (2007) modeled passenger demand employing domestic O&D data (or 10% sample data as it is commonly known) for the top 1,000 city pair routes, IATA's Billing and Settlement Plan (BSP) data, and UK outbound international passenger survey data.

One of the most comprehensive analyses of elasticities in air travel has been reported in Gillen, Morrison, and Stewart (2003). The authors reviewed 21 studies and categorized them in terms of travel characteristics (i.e., business and leisure travel, long-haul vs. short-haul travel), market and route characteristics (i.e., connecting vs. O-D passengers, hub-and-spoke airports, route-specific estimates), model specification and aggregate statistics (i.e., inclusion of income coefficient, inclusion of intermodal substitution, adjusted R-squared values) and data characteristics (i.e. panel vs. time series vs. cross section, country focus, age of the study). Using arbitrary values on these characteristics, Gillen et al. (2003) scored the studies and reported a range of own-price elasticities or fare elasticities based on 254 estimates in the range of -3.20 to 2.5. The midpoint of these estimates was found to be -1.122 with the third quantile reported to be around -0.633 with the first quartile to be -1.418. Skewness (-0.37) of the data distribution was found to be significantly different than the median (-1.122), indicating that estimated fare elasticities were not normally distributed, i.e., there were significant variations in the characteristics of the estimates. Interestingly, none of the studies they reported consisted of discussion on wealth or impact of permanent income on air travel. Due to this omission, Alperovich and Machnes (1994) earlier argued that many existing empirical models may have been mis-specified and thus, estimated elasticity coefficients are exaggerated.

Earlier, Brons, Pels, Nijkamp, and Rietveld (2002) reviewed 37 empirical studies. Using estimates from these studies, Brons et al. (2002) developed a meta model deciphering the key characteristics of air travel. Authors concluded that time series data, inclusion of business passengers, short-haul elasticities and inclusion of an income variable led to smaller fare elasticities. Using this meta model, the authors found that air travelers have become less fare sensitive over time. Again, no consideration was given to wealth or permanent income as opposed to or in addition to current income determining air travel.

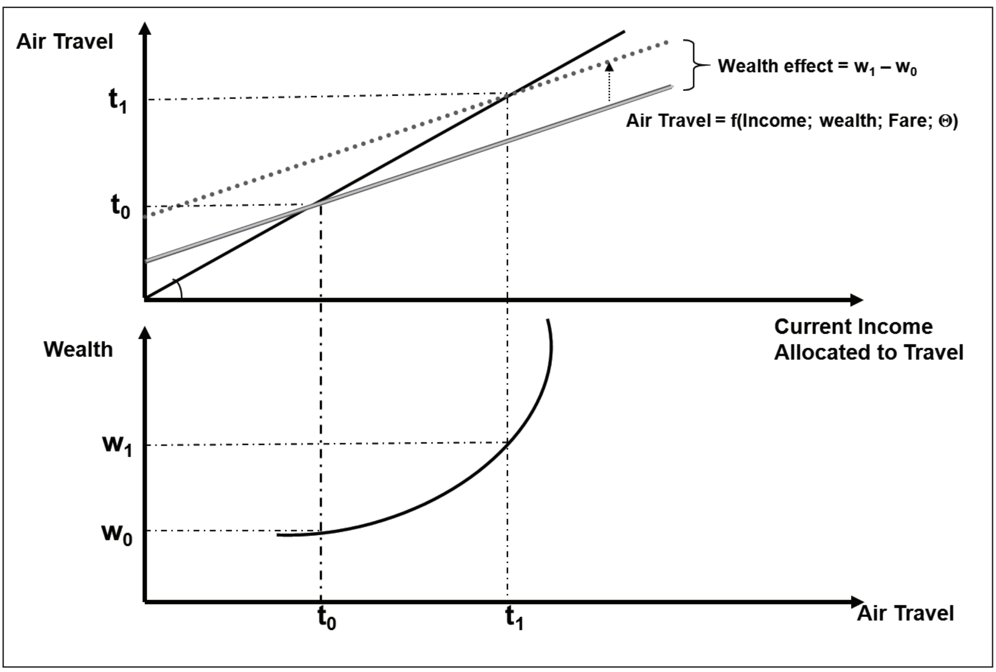
Interestingly, studies determining international air travel tend to use wealth (or some proxy) in addition to other variables. Unlike the determinants of domestic air travel, selective studies used wealth as an explanatory variable for determining international air travel. For example, trends in dwelling prices (as representative of household wealth), consumer expenditure and GDP were found to have strong contemporaneous cyclical correlations, i.e., troughs and peaks tend to go up and down together; however, there is very little trend or secular correlations among these variables. Examining co-movement data for the period 1970-2002, CAA (2005) concluded that "(correlations) suggest that household wealth may be an important predictor of demand for air travel over the *short term*. This may in part be explained by the fact that changes in consumer confidence are closely related to wealth since consumers are known to use asset, and in particular house prices as an indication of the state of the economy.[4] At the same time, however, the preliminary evidence suggests that wealth may add very little, if anything, to *long-term* predictions of demand, over and above the information already contained in the GDP variable" (p. 19; CAA 2005). CAA thus used house prices, in addition to consumer expenditure, air fares, and effective price of tourism, to model and forecast international air passenger traffic for a given market in a particular year.

Noting the lack of some measures of wealth in determining air travel demand in present empirical studies, Alperovich and Machnes (1994) used per-capita non-financial assets (i.e., housing, machinery and equipment, durable goods, and stocks of physical inputs) and per-capita financial assets (i.e., retirement funds, long-term saving deposits, bonds, shares, other deposits, and cash) to represent consumers' wealth. These measures of wealth essentially differ in terms of the degrees of liquidity and are generally implicit in demand models. Using time-series aggregate annual data (1970-1989) from Israel on number of travelers, population, full price of travel, income, financial assets, non-financial assets, and CPI, Alperovich and Machnes (1994) found: (a) air travel from Israel to all foreign destinations is highly elastic in income and inelastic in price; and (b) there was no difference in demand elasticity between financial and non-financial assets and both are shown to be inelastic. The results provided solid support for the central empirical hypothesis that demand for international air travel is determined, other things being equal, by consumers' wealth. Despite these findings, it is interesting to note that none of the later empirical studies reviewed in Brons et al. (2002) and Gillen et al. (2003) incorporated any measure of consumers' wealth in determining demand.

EMPIRICAL FRAMEWORK AND DATA

This section lays out a simple analytical framework where the basic relationship between nominal or current wealth and air travel is investigated together with the standard relationship involving current or nominal income (Figure 7) and air travel. The discussion in the preceding section indicates that wealth has an impact on current consumption and particularly on air travel. The figure below provides one postulated linkage[5] drawing on the literature discussed above. The top part of the panel in Figure 7 depicts the standard relationship between current income allotted to travel and air travel; as current income increases (and allocation of income on travel), so does the air travel. Along with the current income, air travel is also dependent on wealth, air fare, and a host of other factors captured by Θ.

Figure 7: Determinants of Air Travel: Current Income and Household Worth



Following the standard demonstration of the Keynesian cross in determining macroeconomic equilibrium, an intersection between the 45-degree line and air travel function above determines the equilibrium air travel of t_0 corresponding to a given level of allotted current income on travel, holding all other variables constant (upper panel of Figure 7). As nominal or current level of wealth increases, the air travel function shifts upward (dotted line) thus, determining a higher level of equilibrium air travel (t_1) given the same level of allotted current income on travel and all other variables. This establishes the relationship between wealth and air travel as captured in the lower panel of Figure 7, increasing exponentially at first and then leveling out at higher levels of wealth.

The slope of the air travel function or the marginal propensity of air travel, i.e., changes in air travel in response to changes in allotted current income on travel, measures the "pure"[6] elasticity of air travel. As current income allotted on travel goes down, air travel goes down and vice versa, yielding a positive slope that is constant at all income levels.[7]

Air travel is also a function of air fare; so as air fare increases, it is expected that air travel will go down through a downward shift in the air travel function and vice versa. Traditionally, this is captured by fare elasticity and generally estimated to be negative.

Finally, as nominal or current wealth goes up, households feel wealthier and their confidence enhances leading to an increase in air travel causing an upward shift in air travel function (Figure 7: upper panel) and vice versa. However, the sense of being wealthy and its impact on air travel is not constant at all levels of wealth, giving rise to a non-linear relationship between wealth and air travel (lower panel). Increase in air travel due to increase in wealth is faster at lower levels of wealth, i.e., a "novelty" aspect; while at higher levels of wealth, increases in air travel corresponding to increases in wealth slows down, i.e., a "normal" aspect. This leads to the shape of the curve in the lower panel, an empirical hypothesis that will be tested in this study.[8] Earlier empirical studies (see InterVistas 2008 and Brons, 2002) tend to lend some credence to this assertion.

The above relationships underlying the extended passenger demand function can be generally stipulated as follows:

(1) PaxD = f (Current Income, Household wealth, average fare, Θ)

where PaxD denotes the demand for air travel at a particular time t. All variables are denoted at the corresponding time t.

For the empirical analysis presented in this paper, cross section data of current income, household wealth, average fare, and other variables have been assembled for the period 1990:Q1–2010:Q4 or 84 observations in total. Passenger demand is represented by total enplanement (i.e., domestic and international) and come from the U.S. Department of Transportation (see http://www.transtats.bts.gov/Data_Elements.aspx?Data=1). Average fare series is calculated using data from the USDOT and Air Transport Association (see http://www.airlines.org/economics/finance/PaPricesYield.htm). Current income, household wealth, interest income, and all other related data come from U.S. Flow of Funds Accounts (see http://www.federalreserve.gov/releases/z1/).

The above specification is similar to earlier estimation framework from the empirical literature in the sense that it takes into account both current income and average fare. Using the estimated parameters, the standard fare and income responsiveness or elasticities can be easily calculated. However, it differs from most of the earlier studies in two important aspects: (a) the specification in (1) applies a generalized framework involving aggregate current income and wealth to determine and explain passenger air travel, and not a subset of it (e.g., CAA 2005 and Alperovich and Machnes 1994); and (b) it hypothesizes interdependencies determining both passenger demand and household wealth. Unlike the studies that incorporated wealth as an exogenous driver of passenger demand, the present study postulates that wealth can be determined within the empirical system and there are interdependencies within different variables and thus, demand and wealth should be determined as a system of equations as opposed to a single equation for air travel demand.

Estimation, Discussion of Results and Implications for Forecasting

The empirical framework thus hypothesizes that household wealth is determined alongside the passenger demand and there are interdependencies that need to be estimated. Two equations that capture the essence of the empirical relationships and interdependencies are stipulated as a system as follows:

(2) $PaxD = a_0 + a_1 * average\_fare + a_2 * Hh\_Wealth + a_3 * HH\_worthiness$
$+ a_4 * (HH\_Wealth\ squared) + a_5 * lag(1)passengers + g_{pax}$

(3) $Hh\_Wealth = b_0 + b_1 * Income + b_2 * Interest\_rate$
$+ b3 * lag(1)HHwealth + \psi_{wealth}$

Equation (2) is an empirical re-specification of (1) with a few modifications. For example, HH_worthiness, defined as the ratio of household wealth over current income, has been added to the estimating equation. As indicated earlier, the massive expansion of household wealth facilitated household's financial or credit worthiness via increased access to liquidity;[9] conversely, financial worthiness dropped significantly as wealth contracted. This variable is thus considered to be a proxy for credit accessibility and is hypothesized to have a positive impact on passenger air travel. Household wealth (HH_wealth) is hypothesized to have a positive impact on air travel; the more the accumulated wealth, it is likely that households will be able to afford more air travel. HH_wealth squared has been incorporated to test the empirical hypothesis underlying the shape of the air travel function (lower panel) in Figure 7. Average fare has the standard impact; higher the air fares, less the air travel. Finally, given the time series nature of the proposed estimation, a one-period lag of passengers (lag(1)passengers) has been incorporated, as the stationarity test indicated such inclusions to improve the model structure. Results of these tests will be reported and discussed later.

Equation (3) accounts for household wealth (HH_Wealth) that has been hypothesized to depend on current income (Income), interest rate (Interest_rate) and lagged household wealth (lag(1)HHwealth). Current income accounts for household's present contribution to wealth; while the interest rate accounts for interest earnings from the accumulated wealth. Unlike these two flow variables, the biggest determinant of present household wealth is past accumulation of wealth - a stock variable - as captured by one-period lag of household wealth. The endogeniety of household wealth (HH_Wealth) via the third equation and its entry into the second equation as an exogenous variable determine the interdependency in the system consisting of (2) and (3).

Given the hypothesized interdependencies within the two equations above and the nature of the variables, it is likely that the error structures of the equations may be linked to one another. Although each equation seemingly appears to be independent and unrelated, each might actually be linked to one another through errors. Thus, this type of system is called "disturbance-related" or "error-related" regression equations.

Under this circumstance, econometricians often use a seemingly unrelated regression (SUR) or via iteration (ITSUR) technique for estimation. The SUR/ITSUR is applicable when the system consists of two or more equations whose errors may be correlated across equations. The SUR/ITSUR is considered to be appropriate when all the regressors are assumed to be truly exogenous and whose errors satisfy the following conditions:

i. ε_{pax} (error in equation (2)) and ψ_{wealth} (error in equation (3)) have zero means and finite variances;
ii. the variances of errors may differ; and,
iii. there is a presumed correlation between ε_{pax} and ψ_{worth}.

As noted elsewhere (Pindyck and Rubenfeld 1996), ordinary least squares (OLS) methodology, under the conditions of (i) to (iii), suffers from simultaneity bias, i.e., endogenous variables may depend on errors. Given the assumptions that (i) to (iii) are true for the data for reasons stated above, iterative SUR methodology was used for estimation. The ITSUR estimation begins with OLS parameter estimates and improves the estimation in subsequent steps resulting in efficient estimates of the specified parameters.

The summary statistics of key variables are reported in Table 1.

Table 1: Summary of Household Wealth and Air Travel Characteristics

Variable	N	Mean	Median	Maximum	Minimum	Std Dev	Skewness	Kurtosis
Passengers (quarterly)	84	141,820,000	142,480,000	178,430,000	99,845,289	20,054,666	-0.28	-0.74
Household Wealth (in millions)	84	$40,392,584	$41,380,936	$66,007,422	$20,124,360	$14,173,501	0.17	-1.20
Household Income (in millions)	84	$ 7,493,783	$ 7,340,529	$11,509,100	$ 4,163,997	$ 2,307,613	0.25	-1.26
Average airfare (one way)	84	$154	$154	$180	$128	$12	-0.06	-0.58
Interest Rate (%)	84	3.87	4.48	8.25	0.12	2.16	-0.21	-0.83

Source: Based on data available at http://www.transtats.bts.gov/Data_Elements.aspx?Data=1; and http://www.federalreserve.gov/releases/z1/Current/

Average quarterly passengers in the dataset are around 142 million with median value nearby to the mean. With maximum passengers observed during 2007:Q3 while minimum was observed during 1991:Q1 and a standard deviation of 20 million passengers. Skewness value indicates that most of the observations are concentrated on the right of the calculated mean with extreme values located mostly to the left; while Kurtosis indicates that the underlying distribution of data is somewhat flatter than the normal distribution with wider peak and spread around the mean. Household wealth and income averages have been calculated to be around $40 trillion and $7 trillion, respectively; with medians found nearby. Highest wealth was observed during 2007:Q2 while highest income was observed during 2008:Q2, right before the Great Recession began. On average, passengers paid around $154 for one-way fare with a standard deviation of around $12. During the period of the sample, 1990:Q1–2010:Q4, U.S. households, on average, faced an interest rate of 3.9% with wide variations of over two percentage points.

Before the model is described and results discussed, it is important to discuss time series properties of the system. Although the proposed model is not used for forecasting purposes, it is nevertheless important to explore the stationarity properties of the system. Earlier econometric studies (Dickey 2002) established that time series used in econometric applications must be stationary. Generally speaking, stationarity implies that means underlying the series in question (i.e., passengers and household wealth) are constant. While visual examination of data series may be used to accomplish this, econometricians have developed robust tests for examining stationarity. Stationarity of a time series ensures that standard properties of econometric estimation, for example, t-test statistics have approximately normal distribution, are valid. Natural log of the two series, passenger and household wealth, are used together with four lags (i.e., 1 year) in order to test the stationarity property. Dickey (2002) describes two tests for stationarity: unit root test[10] (captured by tau below) and normalized bias test (captured by rho below) and they have been reported in Table 2.

Table 2: Stationarity Tests for Passengers and Household Wealth Series

Type	Lags	Rho	Pr < Rho	Tau	Pr < Tau
Augmented Dickey-Fuller Unit Root Tests: In Pax					
Type	**Lags**	**Rho**	**Pr < Rho**	**Tau**	**Pr < Tau**
Single Mean	**0**	-12.84	0.0585	-2.79	0.0639
	1	-12.6	0.0623	-2.57	0.1026
	2	-2.468	0.7169	-1.36	0.5995
	3	-1.939	0.7819	-1.59	0.483
	4	-4.413	0.4847	-2.04	0.2711
Augmented Dickey-Fuller Unit Root Tests: In Wealth					
Type	**Lags**	**Rho**	**Pr < Rho**	**Tau**	**Pr < Tau**
Single Mean	**0**	-1.12	0.8723	01.5	0.5285
	1	-1.319	0.8521	-1.33	0.6145
	2	-1.69	0.8113	-1.5	0.5305
	3	-1.775	0.8014	-1.39	0.5857
	4	-1.684	0.8118	-1.26	0.6459

Estimated tau indicates that there is evidence to accept unit roots, that is, both series are shown to be stationary; i.e., estimated taus are shown to be not statistically significant (5% or less) in any lags. On the other hand, estimated rhos shows inclusion of first lag, particularly in the case of passengers, may improve the estimated time series properties. Inclusion of one-period lag may also address the issues relating to auto-correlations in the errors, if any. Thus, in addition to the exogenous variables discussed above, one period lags for both passengers and household wealth have been incorporated in respective estimating equations.

The system of the equations has been specified in terms of natural log (ln). The advantage of log-transformed specification is that the estimated parameters can be easily interpreted as elasticity quotients for those that are meaningful. The results of the estimation are reported in Table 3. Aggregate statistics show that the specifications of the system and individual equations are quite robust and statistically significant.

Table 3: Air Travel and Household Wealth: Summary of Residual Errors

Nonlinear ITSUR Summary of Residual Errors									
Equation	**DF Model**	**DF Error**	**SSE**	**MSE**	**RootMSE**	**R-Square**	**Adj R-Sq**	**Durbin Watson**	**Label**
lnpax	6	77	0.2858	0.00371	0.0609	0.8331	0.8223	1.6208	log of quarterly passengers
lnHHwealth	4	79	0.074	0.00094	0.0306	0.9933	0.9931	1.4398	log of household wealth

For example, over 82% of variation in passenger demand (equation (2)) is explained by the variables specified in the above equation; while over 99% of variation in wealth equation (equation (3)) is captured by simple specifications of current income, interest rate, and lagged impact of logged wealth. Both equations have reasonable Durbin-Watson (DW) statistic. The value of DW lies between zero and four. As a general rule, if the DW statistic is equal to two, then, it is expected that the errors are not serially correlated. However, if DW statistic is substantially less than two, there is evidence of positive serial correlation; a value less than 1.0, for example, is certain to ensure positive correlation; i.e., successive errors are correlated. If DW > 2, on the other hand, successive error terms are much different in value to one another on average, i.e., negatively correlated. Estimated DW statistic for equation (1) has been found to be 1.62 while it is 1.44 for equation (2). These values indicate no correlation or slight hints of positive correlations among errors and believed to be unlikely to influence results in any meaningful way. Furthermore, such DW values are often observed in long time series and may not have any material impact since they are not used for forecasting, a task that is not the focus of this paper.

In Table 4, results of the estimation are reported. Some parameters, except those marked with '*', have been found to be statistically significant at the 99% level of significance including fare elasticity, wealth elasticity of passengers, and lagged wealth. Log of one-period lagged passengers is significant at 95% and exponential growth of wealth (i.e., wealth squared) at 90% significance (t-values). It is important to note that all other variables in the wealth equation turn out to be statistically insignificant once lagged wealth effect was incorporated.[11] Finally, all estimated parameters have the "right" signs; i.e., estimated signs conform with those stipulated by the analytical framework, and their magnitudes appear to agree with those reported in the literature.

Table 4: Air Travel and Household Wealth: Estimation Results

Nonlinear ITSUR Parameter Estimates					
Parameter	**Estimate**	**Approx Std Err**	**t Value**	**Approx Pr > |t|**	**Label**
a_1	-0.45519	0.1274	-3.57	0.0006	fare elasticity of passenger
a_2	0.423482	0.0838	5.06	<.0001	wealth elasticity of passenger
a_3	0.123928*	0.0888	1.39	0.167	household worthiness (pax)
a_4	-3.34^{E}-17	1.94^{E}-17	-1.72	0.0888	household wealth squared
a_5	0.217269	0.1047	2.08	0.0412	log of lagged (one-period) passengers
a_0	9.441766	1.5949	5.92	<.0001	pax equation intercept
b_1	0.033001*	0.1286	0.26	0.7982	income elasticity of wealth
b_2	0.002803*	0.00943	0.3	0.7671	interest impact on wealth
b_3	0.0962979	0.0948	10.16	<.0001	lagged impact of log wealth
b_0	0.13441*	0.4322	0.31	0.7566	Wealth equation intercept

* Not statistically significant.

For example, for a 10% sustained increase in average fare (i.e., $17 for one-way average for 2010 based on DOT data), passenger demand has been estimated to decline (estimated a1) by 4.56% or 6.45 million passengers per quarter (i.e., a_1 or fare elasticity of passenger) or almost 29 million passengers[12] for the year at the 2010 average value (see http://www.transtats.bts.gov/Data_Elements.aspx?Data=1 for data), controlling all other variables. That is, the estimated fare effect (-0.45) is found to be relatively unresponsive (or inelastic) on passenger demand. Although the estimated magnitude conforms well with some of the reported results from earlier empirical studies (Gillen et al. 2003 and Brons et al. 2002), it is on the lower side. A fully-specified model incorporating wealth is expected to yield lower fare elasticity, as argued by Alperovich and Machnes (1994).

Second, for each 1% increase in wealth, passenger demand (estimated a_2) would increase by 0.42% (i.e., a_2 or wealth elasticity on passenger); or wealth effect on passengers was found to be relatively inelastic. U.S. net aggregate household wealth stood at around $55 trillion (see http://www.federalreserve.gov/releases/z1/) and total annual passengers stood at a little over 629 million in 2010 (see http://www.transtats.bts.gov/Data_Elements.aspx?Data=1). Thus, for an increase of U.S. $550 billion (1% of $55 trillion), there would be 2.67 million (0.42% of 629.41 million; see http://www.transtats.bts.gov/Data_Elements.aspx?Data=1) additional passengers, holding all else constant. Passenger responsiveness to changes in wealth was found to be relatively inelastic. This finding is consistent with Alperovich and Machnes (1994), where international passenger demand was found to be impacted in the magnitude of 0.38% with respect to financial assets and 0.56% with respect to non-financial assets. Furthermore, the empirical test underlying the postulated shape of the air travel demand function in the lower panel of Figure 7 is captured by using the estimated parameters a_2 and a_4. Combined with a positive a_2 (i.e., first derivative) and negative a_4 (i.e., second derivative) demonstrate that air travel function increases at a diminishing rate as wealth grows.

Third, for a sustained 1% increase in household worthiness (i.e., proportionately larger expansion in wealth in relation to current income), passenger air travel (estimated a3) is expected to increase by 0.12% (a3 or household worthiness impact on passenger), holding all else constant. Although statistically insignificant, passenger demand is relatively inelastic with respect to household worthiness as measured by the ratio of wealth over current income. This is not surprising given the fact that travel as a whole consists of such a small percentage of total PCE services (3% in 2010) and air travel accounts for only a fraction of that expenditure (see http://www.federalreserve.gov/releases/z1/ for more details).

Fourth, one-period lag of passengers appears to influence present air travel (estimated a5). For a 1% increase in last quarter's passengers appears to lead to, controlling for all other variables, almost a 0.22% increase in passengers in the current quarter. Despite the fact that passenger flows are influenced by many factors, including fare, current income and wealth, past passenger flow provides a good indicator of the present passenger flow and estimated a5 confirms this empirically.

Fifth, lagged wealth is strongly influential in determining the present wealth, i.e., estimated b3. A one-period lag demonstrates that there is almost a one-to-one correspondence between last year's wealth and this year's. For example, a 1% increase in last quarter's wealth would have a little over 0.96% increase in the present quarter's wealth. Other effects are captured by flow variables such as income and interest earnings. Although not statistically significant, they appear to have the right signs. For a 10% sustained increase in income, for example, wealth is estimated to increase by 3.3% (i.e., b1 or income elasticity of wealth). That is, wealth is relatively inelastic with respect to changes in income (i.e., income elasticity effect of wealth). Current income for households mostly consists of wage income and other non-wage benefit/income and in many ways is an indicator of the overall economy. Income increase is generally associated with productivity enhancement, tightening labor market conditions leading to an increase in wage income and other resource prices, and overall economic expansion. Thus, as current income increases, it is highly likely that all components of household wealth, i.e., value of real estate, corporate and non-corporate equities, other financial assets including mutual fund shares, and other assets including life insurance, pension fund reserves and miscellaneous assets, would increase as well.

Finally, it is well known that interest rates,[13] as the most potent monetary policy tool, move cyclically with a lag; thus, as the economy goes into recession, interest rates fall and as the economy recovers, interest rates go up. For the overall sample, the estimated coefficient (b2) indicates that if interest rates go up by 1%, household wealth will go up by 0.003%. This finding has a similar interpretation as impact of current income on wealth; as interest rates go up representing overall economic expansion leading to comprehensive improvement in overall wealth.

Equipped with the estimated parameters, an attempt is now made to isolate and calculate the annual passenger loss (i.e., lost demand) due to the decline in household wealth, holding all else constant. From the last peak (2007:Q2) to the trough (2009:Q1), total household wealth loss was calculated to be a little over $17 trillion (i.e., from the peak of $66 trillion to the bottom at $49 trillion); or a loss of around 26%. During this period overall, average total household wealth stood at around $59 trillion (see http://www.federalreserve.gov/releases/z1/ for these numbers and calculations). Corresponding total number of passengers averaged around 659 million per year during these periods[14] (see http://www.transtats.bts.gov/Data_Elements.aspx?Data=1). Given the estimated wealth elasticity of 0.42% and the decline in wealth of 26%, this implies that around 730,000 (i.e., 0.423482% X -26.08% X 657.922 million[15]) passengers did not travel. A comparison of the two years (2008 and 2007) reveals that over 27 million people altogether did not fly; i.e., 679 million in 2007 vs. 652 million in 2008, from the peak of the cycle to trough of the cycle or a decline of little over 4% annually (see http://www.transtats.bts.gov/Data_Elements.aspx?Data=1). Thus, decline in wealth induced lost air travel demand of around 2.6% (i.e., 730,000 /27 million). Furthermore, using the observed average round trip fare during this period ($335), calculated loss due explicitly to the loss in household wealth turned out to be over $244 million.[16]

During 2010, total household wealth expanded by $8 trillion in comparison to the last trough (2009:Q1) despite the fact that average total household wealth is still considerably less than those observed during peak years. For example, household wealth expanded by $8 trillion (or 16%) in 2010:Q4, the last quarter for which data were available, in comparison to the most recent bottom observed in 2009:Q1 ($48 trillion). Although recent expansion recouped some of the losses and average annual wealth now stands at $53 trillion, it is still less than 10% ($6 trillion) of the average size observed during the last peak and trough cycle ($59 trillion) (see http://www.federalreserve.gov/releases/z1/ for more details). During this last period of expansion (i.e., 2009:Q1–2010:Q4), corresponding average total passengers is calculated to be around 624 million (see http://www.transtats.bts.gov/Data_Elements.aspx?Data=1). Using the method used earlier, additional passenger travel induced by the wealth expansion is calculated to be around 435,000 (i.e., 0.423482% X 16.45% X 623.695 million). Notice, however, during these two periods (2009 vs. 2010), total passengers increased by 11.43 million (617.98 million and 629.41 million in 2009 and 2010, respectively), or around 1.90% annually. Wealth-induced increase in passenger travel (435,000) thus accounted for around 3.8% (i.e., 435,000/11.43 million) of the total increase in passengers. A comparison of air travel lost and induced by wealth loss vs. wealth gain, respectively, shows an asymmetry; air travel appears to bounce back more with the increases in wealth gain compared to the air travel lost due to wealth losses (i.e., 2.6% for wealth loss vs. 3.8% for wealth gain).

Given the possibility that a structural model such as proposed above may be used for limited forecasting and/or scenario planning, it is important that the residuals of the estimated models are understood in order to validate the assumptions underlying the estimation technique. In specification and estimation, it is assumed that errors of the equations (2) amd (3) are normally distributed. Table 5 provides the results of normality tests.

As evident that normal distribution for the estimated passenger equation residual cannot be rejected; while that of residuals for household wealth equation cannot be accepted. Two of the three normality tests for the system, as a whole, indicate that normal distribution assumption for the residuals cannot be rejected.

The financial calamity that started off in 2007:Q3 setting off the most severe recession[17] since the Great Depression has had multifarious impacts on all sectors of the economy. While the housing, labor, and credit markets have been the primary focus of policymakers, this analysis demonstrated that the impact had been felt in air travel as well. Decoupling air travel from the cycles of the economy is unlikely in the U.S.; however, their impact may be minimized by conscious business and policy choices. For example, tightening credit environment, along with other cost pressures (i.e., sudden increase in jet fuel price in summer 2008), has disciplined the U.S. domestic airline industry in managing capacity well. Consequently, there had been much less idle capacity and thus, much less downward pressure on fares during the last cycle than earlier ones. The subsequent recovery in demand has brought a healthy improvement in airline financials, yielding overall industry profit for 2010; and the same is expected for 2011 as well.

Table 5: Normality Tests of Residuals

Normality Test			
Equation	**Test Statistic**	**Value**	**Prob**
lnpax	Shapiro-Wilk W	0.96	0.0256
lnHHwealth	Shapiro-Wilk W	0.97	0.2714
System	Mardia Skewness	10.71	0.03
	Mardia Kurtosis	1.3	0.1937
	Henze-Zirkler T	1.85	0.0638

Forecasting challenges from a model that is offered here are no different than those employed in standard econometric estimation and forecasting. In the simple framework presented above, true exogenous variables are average fare, interest rate, and current income. Projecting these variables are no more challenging than projecting, for example, GDP (for current income), interest rate for inflation (inversely related), and inflation for average fare (i.e., adjusted downward due to the fact that overall CPI-U increases faster than the average fare). In comparison to standard specification, however, the proposed model incorporates household wealth, an important variable in determining the long-term or life cycle induced consumption and air travel. Furthermore, varying these three variables, a relatively manageable task, to account for different economic realities or scenarios may also provide corresponding simulated or projected air travel, thus meeting important strategic needs as well.

CONCLUSIONS

This paper is an attempt to bridge an important empirical void between household wealth and its impact on air travel. Examining trends of household wealth and air travel and other related variables over the last two decades, the paper establishes an empirical causality. Despite this linkage and the presence of a theoretical construct, existing empirical literature, interestingly enough, does not incorporate the wealth effect in determining air travel for most of the studies. Consequently, present forecasting does not go beyond incorporating current or nominal income.

Following the guidance of standard macroeconomic literature, the paper builds a simple analytical framework where current income is linked to air travel together with households' accumulation of wealth or permanent income. This framework was then applied to determine passenger air travel together with household wealth in a simultaneous equation system. The empirical results suggest that the framework is highly robust in specification, aggregate statistics, and parameter estimates. Household wealth has been found to be important in determining passenger air travel, together with average fare and past travel. Furthermore, household wealth has been determined to be a function of stock of past wealth accumulations.

The estimated parameters helped to determine the magnitude of lost demand due to the massive wealth loss during the last financial crisis and Great Recession, an area of research that has been generally overlooked. The household wealth loss of U.S. $17 trillion yielded a loss of air travel demand of 730,000, or a loss of revenue of $244 million. As household wealth improved during the last two years, air travel recovered. Some of the lost passenger demand has been recouped (435,000) but a complete wealth-induced recovery still seems far off. Furthermore, wealth expansion tends to increase air travel proportionately more, holding all else constant, than wealth contraction does to reduce air travel.

This model can be used for forecasting macroeconomic air travel trends in the country or in scenario planning. Due to the simplicity of the proposed framework, it holds great promises to generate air travel scenarios corresponding to different projected economic realities (or scenarios), thus meeting strategic needs of air transportation planning. Due to the simplicity and its tractability, the model lacks comprehensibility. For example, future research may separate out the financial assets from non-financial assets and examine the impact of degrees of liquidity on air travel. In a similar vein, household distributions of assets have not been considered in the macro framework presented above; households holding higher wealth may have different spending patterns and air travel than those holding less – an issue that should be addressed in a future empirical framework. These are some of the tasks for future research.

Endnotes

1. See http://online.wsj.com/article/; published on March 11, 2011; and http://www.bloomberg.com/news/; published on March 25, 2011, among many others. Wealth and worth is used interchangeably in this paper. Household's net wealth consists of (a) real estate; (b) corporate and non-corporate equities; (c) other financial assets including mutual fund shares; and (d) other assets including life insurance, pension fund reserves and miscellaneous assets (see http://www.federalreserve.gov/releases/z1/Current/z1.pdf for more details).

2. This is estimated using the following steps; first, operating revenue of US commercial air travel for the system (i.e., domestic and international) as a whole has been accounted for and is estimated to be around $165 billion for the year 2010 (see http://www.transtats.bts.gov/Data_Elements.aspx?Data=1). Second, $30 billion a year has been added towards general aviation revenue (see Commission on the Future of the US Industry 2002, thus totaling over $190 billion as the aggregate value of the sector, using this expenditure accounting method for the year 2010.

3. A relatively slow decline of expenditure on recreational services accompanied with moderately large decline on transportation services during the Great Recession led to spending on vacation without traveling, or *staycation,* i.e., stay home vacation, an altogether new term to characterize this phenomenon (http://en.wikipedia.org/wiki/Staycation).

4. Interestingly, rationalizing quantitative easing-2 (QE2) current Federal Reserve Chairman Ben Bernanke wrote on November 5, 2010: "The FOMC intends to buy an additional $600 billion of longer-term Treasury securities by mid-2011 and will continue to reinvest repayments of principal on its holdings of securities, as it has been doing since August…This approach eased financial conditions in the past and, so far, looks to be effective again. *Stock prices rose* and long-term interest rates fell when investors began to anticipate this additional action. Easier financial conditions will promote economic growth. For example, lower mortgage rates will make housing more affordable and allow more homeowners to refinance. Lower corporate bond rates will encourage investment. And *higher stock prices will boost consumer wealth and help increase confidence, which can also spur spending. Increased spending will lead to higher incomes and profits that, in a virtuous circle, will further support economic expansion*" (author's added italics; published in The Washington Post, op. ed., see http://www.federalreserve.gov/newsevents/other/o_bernanke20101105a.htm).

5. This is a modified version of famous Keynesian cross diagram in the present context. Instead of deriving the demand for air travel from the standard behavioral relationship (i.e., utility-maximization subject to income and wealth), the postulation below derives the relationship using the macro structural relationship between air travel and income allotted to travel and wealth. Using either framework is appropriate; however, the macro relationship has been chosen due to the casting of the central empirical hypothesis in an aggregate macroeconomic context in the paper.

6. In the standard empirical literature, income elasticity is defined as changes in air travel as the result of changes in current or nominal income, a definition that is applied in the empirical framework of the paper as well. However, in demonstrating the relationship between air travel, wealth, and current income (Figure 7), a distinction is made where air travel is related to current income allotted to travel in order to draw the equilibrium in the upper panel. Since the relationship calls for air travel and income allotted to travel (and not total current or nominal income), therefore, it is defined as "true" income elasticity of air travel defined as changes in air travel due to changes in nominal travel budget. Presumably, the "true" elasticity will be much higher compared to observed income elasticity measured on nominal total income.

7. This is an over simplification. It is likely that at higher levels of income, air travel becomes a "normal" good thus losing the novelty (or luxury) characteristics. Income distribution-adjusted absolute values of income (and fare) elasticities have been found to be declining over time (see Schafer 2011). There is indirect evidence which prove this assertion. For example, income elasticities for business travelers are often found to be smaller (in absolute terms) than those observed for the leisure travelers. In other words, leisure travelers, i.e., presumably with relatively lower income, are found to be far more price-sensitive than their counterparts in business, i.e., presumably with higher incomes.

8. After all, how much can one travel by air even if you are the richest person in the world! However, this is an empirical issue, as correctly pointed out by an anonymous referee, which will be tested in this study.

9. Generally speaking, this ratio is calculated to be around five for average household; i.e., household's financial portfolio is five times the current annual income. As wealth expanded, vis-à-vis current income, worthiness of households increased to almost 6.4 (2006:Q1). This facilitated credit worthiness of households making it possible for increased borrowing to finance many components of consumption, including air travel. This is accounted for by inclusion of financial worthiness of household in the second equation.

10. Unit root is a feature of the data process that evolves through time and may lead to problems for statistical inference. Finding a unit root is equivalent to finding that mean and variance of the series (a) evolves over time; (b) departs from a constant value as time goes on; and (c) exhibits that a trend if the movement is predominantly in one direction. Rejection of unit root of a series thus ensures that the time series is stationary.

11. In an earlier version of the paper, wealth accumulated in a past period was not incorporated in determining the wealth equation; i.e., it was defined only in terms of flow variables (income and interest) and both were found to be statistically significant (99%). Once lagged wealth was incorporated, those flow variables lost their statistical significance thus indicating the importance of past wealth in determining current wealth and minimal roles current flows of

income and interest earning can actually make. Given these implications and despite their statistical insignificance, we decided to include the results in the paper.

12. This is calculated as follows: in 2010, total number of passengers was 629.413 million. Multiplying 4.56% to this annual total gives a value of 28.65 or rounded to 29 million passengers. Due to quarterly variations, annualized average total will be different than multiplying 6.45 million passengers by four quarters.

13. Federal fund rates at long-term constant maturity have been used for the estimation. For description and data, see http://www.federalreserve.gov/econresdata/releases/statisticsdata.htm

14. Although both the estimation and discussion refer to passenger enplanement in this paper, the real metric for consideration should be the origin and destination (OD) of passengers. Total passenger enplanement is an artifact of OD passengers (i.e., true demand) and existing airline network (i.e., connections). Since connection passengers result from airline network and passengers' true demand, OD passengers would be less than total passenger enplanement; e.g., corresponding to 659 million total enplanement, OD passenger stood around 431 million (65%). Nevertheless, the central point of this discussion still remains valid, irrespective of passenger metric.

15. Since the first two numbers are in percentages, the multiplication would be: 0.00423482 x -0.26076 x 657.922 million = -726,513 or rounded up to -730,000. This calculation and numerous others involve rounding off involving detailed actual numbers, and thus, may not equal to quick calculations.

16. This is a lower approximation of the total loss because likely lost demand due to wealth contraction would be disproportionately those of business travels. Since wealth is concentrated in higher income households (Schäfer 2011) who are likely to travel more for business than the average household, the loss in revenue is likely to be a lower approximation. In addition, business travelers, on average, pay higher fares. Thus, the lost value is likely to be a few fold higher than what is calculated here as a first approximation.

17. National Bureau of Economic Research (NBER), the national recession dating committee, identified December 2007 as the official start of this recession (see http://www.nber.org/cycles.html). Although the NBER has not dated the official end, the recession ended in June–July 2009 by all accounts.

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