Transportation Research Part A 65 (2014) 92–102

Contents lists available at ScienceDirect

Transportation Research Part A

journal homepage: www.elsevier.com/locate/tra

The asymmetric effects of income and fuel price on air transport demand

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ARTICLE INFO

Article history:
Received 5 January 2014
Received in revised form 23 February 2014
Accepted 1 April 2014
Available online 15 May 2014

Keywords:
Air transport demand
Imperfect reversibility
Asymmetric response
Hysteresis
Econometric modelling

ABSTRACT

Forecasts of passenger demand are an important parameter for aviation planners. Air transport demand models typically assume a perfectly reversible impact of the demand drivers. However, there are reasons to believe that the impacts of some of the demand drivers such as fuel price or income on air transport demand may not be perfectly reversible. Two types of imperfect reversibility, namely asymmetry and hysteresis, are possible. Asymmetry refers to the differences in the demand impacts of a rising price or income from that of a falling price or income. Hysteresis refers to the dependence of the impacts of changing price or income on previous history, especially on previous maximum price or income. We use US time series data and decompose each of fuel price and income into three component series to develop an econometric model for air transport demand that is capable of capturing the potential imperfectly reversible relationships and test for the presence or absence of reversibility. We find statistical evidence of asymmetry and hysteresis – for both, prices and income – in air transport demand. Implications for policy and practice are then discussed.

1. Introduction

Demand for air transport has been ever increasing, most recently being driven by the emerging economies in the world. For example, during the last decade, world-wide air traffic grew by 5%: China and Brazil's domestic market grew by 9.5% and 8.6% respectively, while the mature US domestic market grew by only 0.8% (International Air Transport Association, 2013). Such possible changes in air transport demand in the future are an important planning parameter. Long term demand forecasts are often required for infrastructure planning on capacity expansion or modification and are primarily used by government agencies or airports. On the other hand, short term forecasts are important for operational planning, including airlines' route choice, pricing and revenue management. Because of this importance of demand forecasts, there is a substantial literature on air transport demand modeling (e.g. Profillidis 2000; Lim et al. 2008; Tsekeris 2009; Department for Transport 2009; Wadud 2011, 2013) and, like most other demand models, all of these are based on the assumption of a perfectly reversible and symmetric relationship between demand and its drivers. However, such an assumption has been challenged in other economic relationships in the area of transport and energy, such as those between oil price and energy demand (e.g. Dargay 1992; Gately 1992) or economic output (e.g. Serletis and Istiak 2013), and between income and car ownership (e.g. Pendyala et al. 1995; Dargay 2001). Along the same vein, it is possible that air transport demand can also

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http://dx.doi.org/10.1016/j.tra.2014.04.001
0965-8564/

show an imperfectly reversible or asymmetric relationship with respect to fuel price and/or income. In this paper we explain why such an asymmetry may hold for air transport demand, empirically investigate the presence or absence of such an effect and discuss the potential consequences. To our knowledge, this is the first study to have empirically investigated imperfect reversibility in the context of air transport demand.

The paper is organized as follows. Section 2 reviews the literature on reversible and asymmetric responses, their importance in practice and sets the context for air travel. Section 3 describes the data and econometric model to decipher the potential imperfect reversibility for air transport demand. Section 4 presents the findings while Section 5 concludes.

2. Reversibility, asymmetry, hysteresis

Perfect reversibility of demand or symmetry in demand means that the demand response to an increase in one of the driving factors (e.g. price or income) is exactly of the same magnitude and of opposite direction as the response to an equal reduction in the same factor. Therefore, for a perfectly reversible price effect, demand reductions during an increase in prices will be fully compensated by demand increases during similar price falls (or vice versa). In a natural experiment, this full recovery in consumption was not realized for petrol consumption in most of the developed world during the 1970s oil price increases and subsequent falls. This observation gave rise to a sustained academic interest in imperfect price reversibility or asymmetry in price elasticities of petrol and oil demand in the 1990s. Although such imperfect reversibility was previously discussed and empirically investigated by Wolffram (1971) as early as the 1970s for agricultural supply, Gately (1992) and Dargay (1992) were the first to empirically investigate the issue for petrol consumption from motor vehicles in the USA and UK respectively. Their work was further enhanced by subsequent research in the areas of non-transport fuel demand (Dargay and Gately 1995; Ryan and Plourde 2002), total fuel demand, industrial energy demand (Adeyemi and Hunt, 2007; Adeyemi et al., 2010), vehicle miles travelled (Gately 1992), etc. for different geographic regions and countries (e.g. Dargay 1992 for the UK, Gately 1992 for the USA, Dargay and Gatley, 1997 and Adeyemi et al., 2010 for OECD, Sentenac-Chemin, 2012 for India). There were also evidence of such price asymmetry in demand for telephone calls (Bidwell et al. 1995) and cigarettes (Young 1983).

In addition to the notion of reversibility with respect to rising and falling prices, a second type of reversibility was identified by Gately (1992) for demand for petrol and vehicle miles travelled. Gately (1992) argued that the demand response to price increases could be different depending on price history – more precisely on whether the current price is above or below a previous maximum. Young (1983) also made similar arguments for cigarette demand, but based on the relationship of current price with previous minimum price. This second type of imperfect reversibility is known as hysteresis. Gately (1992) and Young (1983) both found an evidence of hysteresis and the majority of the studies mentioned above utilize a formulation to investigate both types of imperfections. The two types of reversibility with respect to fuel price and income are explained in Fig. 1. Panels (a) and (c) show asymmetry in demand responses, where the demand curve has different slopes during price rises and price falls. Panels (b) and (d) show the changes in slopes beyond certain points as a result of hysteresis.

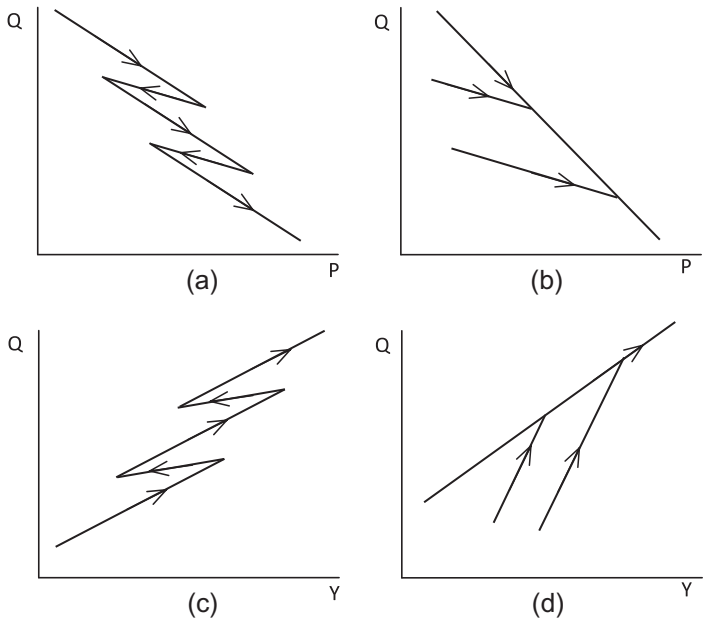

Fig. 1. Hypothetical demand shapes for (a) price asymmetry, (b) price hysteresis, (c) income asymmetry and (d) income hysteresis. Q = quantity, P = price, Y = income.