Some insights into competition between low-cost airlines

D.E. Pitfield

Transport Studies Group, Department of Civil and Building Engineering, Loughborough University, Loughborough, Leicestershire LE11 3TU, UK

ARTICLE INFO

Article history:
Available online 14 April 2009

Keywords:
Low-cost airlines
Pricing strategy
Competition

ABSTRACT

The phenomenon of the wide world growth in low-cost airlines has resulted in a focus on their pricing strategies, on issues of cost recovery and on their impact on the traffic and market shares of legacy carriers or other low-cost carriers when they are in competition, either directly or at adjacent airports. This paper provides a brief overview of the characteristics of these low-cost carriers as well as their history and geography. It goes on to outline ways in which these carriers compete and manage demand, ranging from price competition to advertising; some of these methods directly reflect their special characteristics. Some empirical evidence is presented which indicates a correlation in fare setting behaviour between competitors and insights are offered on cost recovery.

The impact of the start-up of low-cost carriers is also analysed, focusing on their impacts on other low-cost carriers. The case of Ryanair competing with easyJet on London–Venice is examined along with Southwest and Frontier on Denver–Las Vegas.

1. Introduction

Direct competition between airlines used to be relatively rare as many routes were too thin to justify competition, or the bilateral air service agreements between countries limited competition to the flag carriers. The existence of alliances and other forms of cooperation between airlines could also limit competitive behaviour. Where these factors were not at work, or where their influence was less, competition tended to often focus on managing frequency to gain market share rather than on price competition, for example, on the north Atlantic.1 Domestic competition has been seen at least since deregulation in the US and appeared in the UK before the final package of EU liberalisation that facilitated the emergence of their low-cost carriers. An early study used time series analysis to investigate competition between British Airways and British Midland, now BMI (Pitfield, 1993).

More recent work has investigated the impact of Ryanair start-ups on route traffic, where this typically involves secondary or adjacent airports (Morrison, 2001), and its impact on market share (Pitfield, 2007). The post-1990 impact of some start-ups by Southwest in the US (Pitfield, 2008) has also been examined. Particular instances within these cited works allow conclusions to be drawn on the competition between low-cost carriers and price competition can also be examined (Pitfield, 2005a, 2005b).

The next section of this paper outlines the history of the low-cost carriers. Section 3 describes their geographical spread with the next section detailing the characteristics of the carriers and how they compete and manage demand. It is concluded that much more needs to be done to understand this area and that Sections 7 and 8 have a contribution to make here. Section 5 summarises the ARIMA modelling and Section 6 details the data before 7 empirically outlines the pricing and cost recovery implications of low-cost carrier competition and some inferences on pricing behaviour are drawn. The penultimate section identifies the impact of Ryanair and Southwest on some route starts identified, as well as their impact on low-cost competition. The original papers referred to were largely concerned with the impact on legacy carriers. Section 9 offers some conclusions.

2. The emergence of low-cost carriers

Southwest was formed in 1971 and initially operated in Texas. It began to spread its service to the rest of the US with the 1978 deregulation of air transport (Calder, 2002). As can be seen in Section 3, there are a number of other low-cost carriers in North America. The impetus to the growth of low-cost carriers in Europe came from the liberalising effects of the European Third Package in 1993 and Ryanair is notable in initially imitating Southwest’s mode of operation within Europe. These examples have prompted the growth in other areas of the world where either the internal...
geography and economics represent opportunities for development or where air service agreements allow operations between countries.

3. The geographical distribution of low-cost carriers

A website that lists Low-Cost Airlines (2008) shows a worldwide total of 124 in April 2008, with 17 in North America including 7 in Mexico, 3 in Latin America all in Brazil, 6 in Oceania, with half in Australia and half in New Zealand and 6 also in Africa with 3 of those in South Africa. The demise of ATA in the US, a Southwest code share partner in early April 2008 when it filed for bankruptcy and discontinued operations, is reflected in this listing by its absence but Skybus Airlines, that experienced the same, is still included. Frontier Airlines filed for Chapter 11 on April 13th but is included as it continued operations. Amongst the most notable are Southwest, the first low-cost carrier and Jetblue in the US, GOL in Brazil where it only conducts internal flights, Virgin Blue in Australia and Kulula in South Africa.

There are 27 low-cost airlines listed for Asia with a majority of 8 for one country in India and a further 65 in Europe with 16 of these, including the largest carriers, being based in the UK and Ireland. In Asia the demise of Oasis Hong Kong Airlines on the 4th April is overlooked but Tiger Airways, which investments from the Ryan family helped to found, is missing from the listing. The worldwide total of operating carriers may, in fact, still be around 124 but constitute a slightly different membership. The most notable carriers here are Air Asia from Malaysia, Asia’s first low-cost carrier, Air Deccan, the first in India, Spring Airlines based in Shanghai, China along with Ryanair and easyjet, the relative giants of the European scene. Many of the non-European low-cost carriers only offer services domestically, in part, as geographically they have large markets.4

4. Characteristics of low-cost carriers: competition and demand management

As Williams (2001) notes, all low-cost carriers differ in the balance of characteristics that they offer and these define their low-cost character. Some costs are not subjected to particular control by the low-cost carriers such as fuel burn and en-route navigation charges but many other influences on costs per seat km can be influenced. Aircraft turn round times have an influence on aircraft utilisation and are a major factor in controlling such costs along with aircraft type, where a commonality of type can affect main-tenance and training costs, seat configuration, which allows more passengers to be loaded, the number of crew, which if reduced can lower labour costs and the choice of base and destination airport, that can reduce landing fees and direct ticketless selling, which avoids administrative costs.4 Administrative costs are also elimi-nated by simplifying yield management where at any point in time prior to departure the vacant seats have a single price which rises as capacity is approached to maximize yield per departure.

These characteristics have a major influence on the carrier’s ability to compete with other low-cost carriers or legacy carriers. If the competition is fare-based, lower fares can be justified if costs are lower and costs can be recovered.5 These transparent fares suit both business and leisure travellers allowing both segments the choice to customise their trips (Mason, 2005). The demands on other revenues are also reduced if costs are reduced, although to the extent that these revenue streams can be exploited, allow fares to be lower again. Such revenues emanate from hotel bookings, car hire, and other items available as detailed on airline websites, the sale of on-board goods and services as well as charges for loading baggage in the hold, having hand baggage only and checking-in at the airport rather than on the web.

Other characteristics allow the airlines to manage demand. Legacy carriers compete by managing frequency and low-cost carriers can do the same. Flight timings will also affect demand as will the range of destinations offered (Mason, 2005). Press and television and Internet advertising can also be used to manage demand, along with press releases and information provided by email to website subscribers and frequent flyer promotions. The advent of low-cost terminals with designs to especially suit low-cost carriers can also affect a carrier’s choice of airport as well as the subsequent passengers of that airline. The terminal at Kuala Lumpur International Airport is a case in point, although it could be argued that East Midlands Airport, near Nottingham, in the UK, has several desirable but apparently unplanned yet suitable facilities in that air bridges are not used and aircraft park close to a one-storey terminal building. Airline lounges may also have an influence although the author is not aware that this is a tool utilised by low-cost carriers.

Research that has begun to investigate the impact of these demand management and competitive tools is sparse (an exception is Ryley & Davison, 2007); the focus is usually on price and income elasticities with little attention given to changes in consumer preferences at a disaggregate level. More evidence to back up the arguments in this section are clearly desirable and some of this is provided in the Sections 7 and 8.

5. An overview of ARIMA modelling

McDowall et al. (1980) and Wei (1994) provide good introduc-tions to ARIMA modelling, cross correlation and intervention analysis as well as the treatment of goodness-of-fit. An indebted-ness to previous publications by Pitfield (2005a, 2005b, 2007, 2008), where the techniques employed and the data used is over-viewed in the airline applications cited, is inevitable in the following sections.

If an ARIMA model replicates the fluctuations and main turning movements in the original data it will generate acceptable goodness-of-fit statistics and the unexplained residuals will be white noise. All the indigenous factors that cause variation in the original data will be covered by the model.

For the price data, such a model needs calibrating without seasonal components as the data series has a total duration of days. The data may first be made stationary by differencing before the model form is identified by examining Autocorrelation Functions (ACF) and Partial Autocorrelation Functions (PACF) before checking for the calibrated models that the Box–Ljung Q statistics indicate white noise residuals. It is then that the cross correlation can be

---

2 This will also have to do with Air Service Agreements between countries.
3 This suggests that long haul low-cost operations cannot utilise this factor as effectively as short haul carriers.
4 It is also argued that using only one aircraft door without the use of air bridges can speed this process but contrast the operations of Southwest.
5 There is some doubt on carrier’s ability to do this when in competition, see Pitfield (2005b).
6 These range from airport transfer, to trips and tours, gift vouchers, credit cards, home utility bills and travel, home, car and life insurance.
7 It is often the case, it seems, that travellers are choosing a time window in which to have a break, and then an airport and an airline that offers a wider range of destinations.
calculated on these residuals to determine the correlation of fares between airlines not explained by their dependency on their own past variations in value in the ARIMA models and the size of these correlations can be compared.

An Autoregressive (AR) process with one parameter can be written as AR(1) where the raw data is $Y_t$, then the differenced data is $z_t = Y_t - Y_{t-1}$.

$$z_t = \theta_1 z_{t-1} + a_t \quad (1)$$

and using the backshift operator, B

$$(1 - \theta_1 B) z_t = a_t \quad (2)$$

An AR(2) process is

$$z_t = \theta_1 z_{t-1} + \theta_2 z_{t-2} + a_t \quad (3)$$

or

$$(1 - \theta_1 B - \theta_2 B^2) z_t = a_t \quad (4)$$

A simple Moving Average (MA) process again with one parameter is MA(1)

$$z_t = a_t - \theta_1 a_{t-1} \quad (5)$$

or

$$z_t = (1 - \theta_1 B) a_t \quad (6)$$

And a MA(2) process is

$$z_t = a_t - \theta_1 a_{t-1} - \theta_2 a_{t-2} \quad (7)$$

or

$$(1 - \theta_1 B - \theta_2 B^2) a_t \quad (8)$$

A mixed model can be written as either an AR or MA process, for example, for an ARIMA (1,1) model

$$z_t = \theta_1 z_{t-1} + \lambda a_{t-1} \quad (9)$$

or

$$(1 - \theta_1 B) z_t = (1 - \lambda B) a_t \quad (10)$$

For the monthly traffic data a model is calibrated, including seasonal components, as this is appropriate for data of longer duration. The model is determined for the data before the commencement of Southwest or Ryanair service, then the same model form, plus an intervention variable, is applied to the whole data series to establish the impact on the total series of the start-up. This can then be compared to the size of actual market shares and inferences drawn on the impact of competition.

The procedures followed for calibrating these passenger data models are overviewed below as they are a little more complicated than that required for the price data. For the monthly data, from 1990 to 1999 for Southwest and 1991 for Ryanair, a logarithmic transformation is first imposed so that the series is forced to have a constant variance. Plots of both ACF and PACF are examined at periodic lags of 12 months to see if seasonal differencing is required. The ACF and PACF plots are then used to determine whether an AR or MA model is appropriate along with the number of parameters, with a preference to avoid some mixed models and those with a large number of parameters. ACF and PACF plots are then calculated for the residuals of this model to see what the non-seasonal form is and whether non-seasonal differencing is required. The residuals from this combined model must have white noise residuals and this can be determined from the Box–Ljung Q statistics and the ACF of the residuals.

An abrupt step function is used for the intervention term even though it might take a variety of forms. This is justified as it is apparent from the passenger data that the start-up of both of these airlines has immediate impact. This coefficient is then properly interpreted as representing the impact on the whole time series. It is also necessary to cater for the impact of any other exogenous impacts on the data and this is done for the terrorist attacks of 9/11 for the US data where it is obvious that the effects are marked.

### 6. Data

#### 6.1. Temporal fares data

The fares data was collected for 2003. Thirty days worth of data was observed for competing airlines by noting the fares offered at midday before departures on Saturday 13th December. This date was chosen so that weekend and longer leisure breaks would be included in the departures. Leisure destinations were chosen so that price was likely to be an important competitive factor. In addition, flights to destinations that had similar departure times that price was likely to be an important competitive factor. In addition, flights to destinations that had similar departure times were included. Competing airlines with similar departure times were included. This type of data has since been collected by a variety of researchers, for example, Barbot (2004) and Button and Vega (2006, 2007).

At the time of the analysis, East Midlands Airport (EMA), a regional airport located close to the East Midlands cities of Nottingham, Derby and Leicester which, in that year, had a passenger throughput of 3.2 million passengers per annum (mppa), was the only UK airport to have directly competing low-cost carriers. These were easyjet and bmiBaby. Initially, the announcement of the British Airways subsidiary GO that it would operate from EMA induced British Midland (now, BMI) to found bmiBaby. GO was later sold to easyJet.

A number of competing routes were considered for analysis and those chosen are shown in Pitfield (2005a). Here the results for

---

8 This is also the argument advanced and tested in Pitfield (2007).
Malaga and Alicante are reproduced as instructive illustrations of the findings. They were chosen initially not only as leisure destinations but also because their departure times were similar. Indeed, the Alicante services departed within 10 min of each other. It is noteworthy that at this time easyJet was a much more mature low-cost carrier than bmibaby. Now, of course, an even more mature low-cost carrier is also at EMA, Ryanair, with a large service offering.

6.2. Passengers carried

The UK Civil Aviation Authority (CAA) provides data on scheduled origin–destination passengers carried between countries, cities and airports, with more recent data available on its website (see CAA website). The US Bureau of Transportation Statistics (BTS) Form 100 scheduled origin–destination passenger data is available online from 1990 (Bureau of Transportation Statistics, 2006) giving city and airport traffic domestically. From both sources, monthly totals of passengers carried can be determined. The US source also easily enables the airline to be determined along with the frequency of service and other detail, for example, aircraft type and great circle distance. The UK data requires that the monthly OAG guide (for February 2003, see OAG, 2003) is consulted to determine the airline, frequency of service and aircraft type as the CAA data simply gives airport to airport origin–destination passengers. This will involve OAG guides covering winter and summer schedules. The US data is therefore more exact overall, however, the focus here is on passengers.

For both UK and US cases, airports were chosen where, respectively, Ryanair and Southwest operated and where there was a time history of service on the route before either commenced service. This enables an ARIMA model to be developed prior to the intervention but results in the exclusion of some routes for both Ryanair and Southwest, for example, to Ireland for Ryanair, and for Southwest where Southwest started before 1990.

Of those analysed in Pitfield (2007, 2008), the cases of London–Venice (1991–2003) and Denver (DEN)–Las Vegas (LAS), (1990–2006) are reproduced here. In both cases, these are the best examples of competition between low-cost carriers previously analysed. For the European case, it is Ryanair competing with firstly, GO, and then easyJet along with legacy carriers. For the US case, it is Southwest competing with Frontier, along with United and others. In the European case, the low-cost carrier competitors use different airports at origin and destination whereas in the US case, the airports used by the competitors are identical. Pitfield (2007) shows that the impact of start-up should be higher in the latter case due to not using secondary airports but that the impact should be correspondingly reduced because of the presence of low-cost carrier competition.

7. The pricing behaviour of low-cost carriers in competition

7.1. Temporal fares data and cross correlation analysis

7.1.1. Malaga

Temporal fares data is shown in Fig. 1 for the two airlines. easyJet seems to vary fares before departure in a fashion that would...
be expected, that is, low in advance and increasing as the departure date is approached. However, the temporal fares data for bmibaby does not indicate such a pattern.

The data was first differenced to ensure stationarity and the ACF and PACF plots are shown in Fig. 2. The model prescription for bmibaby seems to be an AR (1) model, as in Eq. (2), but the prescription for easyjet is less clear cut. As a result, all of the relatively parsimonious models described in Eqs. (1)–(10) were tried and that with the best goodness-of-fit selected. For easyjet this is a MA (1) model as shown in Eq. (6). The detailed results on the parameters, \( t \) statistics and goodness-of-fit statistics, such as the root mean square error, Theil’s Inequality coefficient (for details on these statistics see Pitfield, 2007), the Schwartz Bayesian Criterion (SBC) and the Akaike Information Criterion (AIC) are given in Pitfield (2005a).

When the Box–Ljung Q statistics are checked to ensure that the residuals are white noise, the degree of autocorrelation in the fitted model can be shown. This is the dependence of current fares on the airline’s past fare values. However, the main thrust of this ARIMA modelling is to calculate the Cross Correlation Function (CCF) between the two filtered series. Whereas the models represent the dependence on past values; the correlation between what is not explained in this way, represents the interdependence of the two airlines’ price setting. This is shown in Fig. 3 and has a coefficient value of 0.452 with a lag of one day. bmibaby fares follow easyJet fares; the novice low-cost carrier is following the more experienced carrier. This seems to be a textbook case of price leadership. However, this relationship is less strong than those identified in the models. Yield management is more influenced by the variation in passenger numbers and resultant load factors as the airline varies its fares.

7.1.2. Alicante

Fig. 4 shows the temporal fares data for the two airlines to Alicante. Differencing the data in these two cases and then computing ACF and PACF values do not result in any clear prescription on the nature of the model or the number of parameters. But if it is considered that the original untransformed data are sufficiently stationary, then the ACF and PACF calculations, shown in Fig. 5, suggest both series are AR (1) models and white noise residuals result. The ACF for the fitted model is shown in Fig. 6 and indicates the degree of correlation for both airlines current fares with the fares one day previously. However, this relationship is less strong than the CCF at 0.808 with zero lag shown in Fig. 7.

Although this is behaviourally problematic to interpret, it is clear that this correlation in fares is more important than past dependence. It suggest that both airlines are experiencing similar variations in demand which results in them managing yield and setting fares so that these are positively correlated. The full results are in Pitfield (2005a).

7.2. Price setting, market morphology and cost recovery

Relatively little attention has been paid to the question of direct competition between low-cost carriers but some evidence on price setting has been summarised here. The connection between these duopolistic markets and cost recovery has received even less attention. Where such markets exist, it is clear from Pitfield (2005b) that there is a threat to the recovery of all fixed costs. Resort may have to be made to the many other sources of income beyond the fare box to help in cost recovery. Of course, if the carriers end up in a monopolistic situation with little threat of market entry, then questions of cost recovery become much less urgent and less difficult. It seems evident that there is a requirement for more research in this area and that this would be facilitated if data availability improved on yield management and cost.

8. Generated traffic and the impact on competitors of low-cost carrier start-ups

Low-Cost carriers have generated new traffic and gained market share from legacy and charter carriers (Graham, 2006; Mason, 2005; Pitfield, 2007). This is also one of the points made by the UK Civil Aviation Authority (2006) in a review of low-cost carriers. Pitfield (2007) examined a variety of Ryanair start-ups from London Stansted (STN) to destinations in Europe. These were Hamburg, Stockholm, Genoa, Pisa and Venice and seemingly robust estimates of the airline’s impact on the market and market shares of carriers

---

**Fig. 3.** CCF plot: Malaga.

**Fig. 4.** Fares from EMA to Alicante.
were found. One of those cases is examined here from a slightly different perspective of low-cost competition, that of London to Venice. Pitfield (2008) undertakes a similar analysis for Southwest in the US where a variety of US corridors are examined. Again, one of these cases, that of Denver to Las Vegas allows the competition between two low-cost carriers to be focused on.

8.1. London–Venice

Two airports serve Venice, Marco Polo (VCE) is the main airport but Treviso (TSF), which is also served, is only some 20 miles away. At different times, British Airways and Alitalia, the flag carriers, served the route between the cities, sometimes using London Gatwick (LGW) instead of London Heathrow (LHR), as well as BMI British Midland and Volare. Ryanair started service to TSF in 1998 from London Stansted (STN) and later the same year, GO, which became easyJet, started to serve VCE also from STN. This is an instance of direct competition but where Ryanair is using two secondary airports.

Fig. 8 and Table 1 detail the traffic and large percentage increases are shown, both in the totals and in Ryanair’s traffic. Rates of growth per annum by Ryanair were higher than growth to the destination in general. After 2000, Ryanair’s traffic continued to grow whilst easyjet’s stabilized. Alitalia stopped serving the route in 2002 and appears to be the major casualty of the competition offered by the start-ups of the two low-cost carriers. Fig. 9 illustrates the market shares by airport and so airline, given the OAG guide data, and it can be seen that the low-cost carriers had over 50 percent of the market. It seems that LGW was the major airport casualty and this again implies that Alitalia was badly affected.

If logarithms of the traffic data are seasonally and regularly differenced, inspection of the ACF and PACF plots suggests a mixed autoregressive and moving average model with one parameter in each function. Abrupt intervention terms are then specified for both the start of Ryanair and GO (which became an easyjet service). Table 2 shows that these start-ups increased the market by 26 and 24 percent respectively. Ryanair’s actual market share in 2003 was 63 percent, so it added to the market and then took share from its competitors. easyjet’s share at the same time was 19.6 percent, so it appears Ryanair gained from easyJet, as this share was less than its initial impact on the market, as well as severely impacting Alitalia.

8.2. Denver–Las Vegas

Southwest is often seen as the archetypal low-cost carrier and their approach to business (Dogannis, 2006; Gittel, 2003) and their competitive effect and growth have long been the subject of enquiry (Dresner, Chris Lin, & Windle, 1996; Morrison, 2001; Richards, 1996; Vowles, 2001). Pitfield (2008) examines a variety of US air transport corridors using the same methodology as that used in the previously cited Ryanair study to estimate the impact of
Southwest's recent route starts and compares those to the impacts found for Ryanair. One of the routes covered is Denver to Las Vegas where Southwest's impact was significant and where a better example of competition is given than that of Southwest with

Fig. 6. ACF plots for ARIMA models: Alicante.

Fig. 7. CCF plot: Alicante.

Southwest's recent route starts and compares those to the impacts found for Ryanair. One of the routes covered is Denver to Las Vegas where Southwest's impact was significant and where a better example of competition is given than that of Southwest with


Southwest started serving the Denver–Las Vegas route at the beginning of 2006. Up until then, the main carrier on the route was United, although it is also served by Frontier Airlines, another low-cost carrier based at Denver. Table 3 shows that Southwest had a nearly 20 percent share of the market in its first year of operation and Fig. 10 shows the immediate impact on traffic growth, so an abrupt intervention term seems appropriate.

However, as Southwest’s start-up is so recent, it is necessary to model the series up to first major endogenous influence on the series, that of September 11th 2001. The monthly traffic statistics

<table>
<thead>
<tr>
<th>Year</th>
<th>Route</th>
<th>LGW-VCE</th>
<th>LHR-VCE</th>
<th>LCY-VCE</th>
<th>STN-TSF</th>
<th>STN-VCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No %</td>
<td>No %</td>
<td>No %</td>
<td>No %</td>
<td>No %</td>
<td>No %</td>
</tr>
<tr>
<td>1991</td>
<td>0 52%</td>
<td>0 48%</td>
<td>0 51%</td>
<td>0 49%</td>
<td>0 50%</td>
<td>0 50%</td>
</tr>
<tr>
<td>1992</td>
<td>0 22%</td>
<td>0 18%</td>
<td>0 23%</td>
<td>0 22%</td>
<td>0 23%</td>
<td>0 23%</td>
</tr>
<tr>
<td>1993</td>
<td>0 21%</td>
<td>0 19%</td>
<td>0 22%</td>
<td>0 21%</td>
<td>0 22%</td>
<td>0 22%</td>
</tr>
<tr>
<td>1994</td>
<td>0 17%</td>
<td>0 15%</td>
<td>0 18%</td>
<td>0 17%</td>
<td>0 18%</td>
<td>0 18%</td>
</tr>
<tr>
<td>1995</td>
<td>0 13%</td>
<td>0 12%</td>
<td>0 14%</td>
<td>0 13%</td>
<td>0 14%</td>
<td>0 14%</td>
</tr>
<tr>
<td>1996</td>
<td>0 11%</td>
<td>0 10%</td>
<td>0 12%</td>
<td>0 11%</td>
<td>0 12%</td>
<td>0 12%</td>
</tr>
<tr>
<td>1997</td>
<td>0 9%</td>
<td>0 8%</td>
<td>0 10%</td>
<td>0 9%</td>
<td>0 10%</td>
<td>0 10%</td>
</tr>
<tr>
<td>1998</td>
<td>0 7%</td>
<td>0 6%</td>
<td>0 8%</td>
<td>0 7%</td>
<td>0 8%</td>
<td>0 8%</td>
</tr>
<tr>
<td>1999</td>
<td>0 5%</td>
<td>0 4%</td>
<td>0 6%</td>
<td>0 5%</td>
<td>0 6%</td>
<td>0 6%</td>
</tr>
<tr>
<td>2000</td>
<td>0 3%</td>
<td>0 2%</td>
<td>0 3%</td>
<td>0 3%</td>
<td>0 3%</td>
<td>0 3%</td>
</tr>
<tr>
<td>2001</td>
<td>0 2%</td>
<td>0 1%</td>
<td>0 2%</td>
<td>0 2%</td>
<td>0 2%</td>
<td>0 2%</td>
</tr>
<tr>
<td>2002</td>
<td>0 1%</td>
<td>0 0%</td>
<td>0 2%</td>
<td>0 1%</td>
<td>0 2%</td>
<td>0 2%</td>
</tr>
<tr>
<td>2003</td>
<td>0 0%</td>
<td>0 0%</td>
<td>0 0%</td>
<td>0 0%</td>
<td>0 0%</td>
<td>0 0%</td>
</tr>
</tbody>
</table>

n.c. not calculated.

Fig. 9. London to Venice market share.
show a fall of 33 percent at the end of 2001 with a return to previous traffic levels by spring 2002. So this is also an abrupt intervention.

After a logarithmic transformation and seasonal and non-seasonal differencing, the appropriate ARIMA model up to 2001 has a single non-seasonal autoregressive parameter and a pair of similar seasonal parameters. This model has white noise residuals. If this model form is then applied to the whole data series, with a pair of binary intervention variables, the model of Table 4 results.

The Southwest start-up swelled the route traffic by 18 percent but it actually achieved a slightly higher market share. The inference is that it took some share from its competitors. The 9/11 intervention seems very large but can be argued to be an appropriate finding consistent with the counterfactual view of the impact of 9/11 given in Blunk, Clark, and McGibany (2006).

Can any explanation be offered on the size of the Southwest effect? Pitfield (2008) shows a paradigm of impacts of low-cost carriers and it is clear that the impact should be relatively large as secondary airports are not used. However, the presence of a competing low-cost carrier usually lessens the potential impact as will the presence of a strong legacy carrier.

Despite the growth of Southwest traffic in its first year of operation, Frontier still retained a larger share of this market than Southwest at 25.25 percent, but this was reduced from their 28.39 percent share of the smaller overall market in 2005. It is likely that this competition to Las Vegas had some impact on Frontier’s economic viability by 2008, albeit the Las Vegas route is one of some 50 plus domestic ones served by them from Denver. Southwest in 2006 also served some of these destinations and had notable service levels to 10 destinations including Las Vegas as well as Baltimore, Chicago, Houston, Kansas City, Nashville, Phoenix, Salt Lake City, San Diego and St Louis. In May 2008 Southwest announced its intention to serve three new destinations from Denver, to Fort Lauderdale, Sacramento and New Orleans, expanding its non stop daily destinations from the initial three in 2006 to 64 by August 2008. The first two of these cities are also served by Frontier and it is clear that the growth of Southwest over these two years must have impacted the economic viability of Frontier. Indeed, it could be argued that their filing for Chapter 11 is an indication that not all fixed costs are being covered in this competitive environment.

9. Conclusion

This paper aimed to summarise previously published evidence on low-cost carrier competition. It was pointed out that price competition is one way that the carriers compete and manage demand and yield. Low-Cost carrier price setting demonstrates, from the little evidence available, a correlation in fares, and on one occasion, a one day lag in a CCF suggests price leadership. More evidence is needed on fares as well as evidence on the other competitive tools utilised by low-cost carriers that help to manage yield.

Evidence was also summarised on the start-up impacts on traffic of two low-cost carriers and inferences drawn, on the basis of their market share, on their impact on competitors. The section on pricing concluded that in a competitive state, there is a risk that fixed costs are not covered by fares and this may be reflected in one of the start-ups examined. Although Ryanair and easyJet continue to serve Venice from London, Frontier has filed for Chapter 11 and may not be covering fixed costs in its attempt to deal with the competition offered by Southwest on many routes out of Denver, including that to Las Vegas. Ryanair and Southwest both grew the markets they entered on start-up and Ryanair appears to have a larger impact on its competitors over a period than Southwest did in the one year initially monitored here. However, more recent evidence suggests that the impacts of both are considerable. Although easyJet continue in Europe, Alitalia

### Table 2

<table>
<thead>
<tr>
<th>Venice intervention model – with regular differencing.</th>
<th>Parameters</th>
<th>t Tests</th>
<th>Goodness-of-fit</th>
</tr>
</thead>
<tbody>
<tr>
<td>MA1</td>
<td>0.565</td>
<td>8.019</td>
<td>SE = 0.084</td>
</tr>
<tr>
<td>SAR1</td>
<td>−0.458</td>
<td>−5.981</td>
<td>Log Likelihood = 151.540</td>
</tr>
<tr>
<td>Intervention – Ryanair</td>
<td>0.258</td>
<td>4.548</td>
<td>AIC = −295.081</td>
</tr>
<tr>
<td>Intervention – GO</td>
<td>0.236</td>
<td>4.165</td>
<td>SBC = 283.229</td>
</tr>
<tr>
<td>RMS – 1990</td>
<td>0.037</td>
<td>8.019</td>
<td>$U^m = 0.003$, $U^p = 0.001$, $U^f = 0.995$</td>
</tr>
<tr>
<td>SAR2</td>
<td>0.60</td>
<td>8.44</td>
<td>Log Likelihood = 203.87</td>
</tr>
<tr>
<td>Intervention – 9/11</td>
<td>−0.31</td>
<td>−4.26</td>
<td>AIC = −397.74</td>
</tr>
<tr>
<td>SWest Intervention</td>
<td>0.18</td>
<td>2.17</td>
<td>SBC = 361.48</td>
</tr>
<tr>
<td>RMS – 7724.80</td>
<td>0.04</td>
<td>5.98</td>
<td>$U^m = 0.001$, $U^p = 0.995$</td>
</tr>
</tbody>
</table>

**Fig. 10.** Denver–Las Vegas monthly traffic 1990–2006.

### Table 3

<table>
<thead>
<tr>
<th>Denver–Las Vegas 1990–2006.</th>
<th>Year</th>
<th>Total Pax</th>
<th>Southwest %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>695,184</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1991</td>
<td>714,951</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1992</td>
<td>822,614</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1993</td>
<td>826,153</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1994</td>
<td>913,569</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1995</td>
<td>847,131</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td>978,405</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1997</td>
<td>966,317</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1998</td>
<td>892,906</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>1,079,639</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>1,104,609</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>1,051,445</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>1,043,382</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>1,212,509</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>1,347,435</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>1,473,479</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>1,595,090</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 4**

<table>
<thead>
<tr>
<th>Denver–Las Vegas results.</th>
<th>Parameters</th>
<th>t Tests</th>
<th>Goodness-of-fit</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR1</td>
<td>−0.24</td>
<td>−3.39</td>
<td>SE = 0.08</td>
</tr>
<tr>
<td>SAR1</td>
<td>−0.60</td>
<td>−8.44</td>
<td>Log Likelihood = 203.87</td>
</tr>
<tr>
<td>SAR2</td>
<td>−0.31</td>
<td>−4.26</td>
<td>AIC = −397.74</td>
</tr>
<tr>
<td>9/11 Intervention</td>
<td>−0.42</td>
<td>−5.07</td>
<td>SBC = 361.48</td>
</tr>
<tr>
<td>SWest Intervention</td>
<td>0.18</td>
<td>2.17</td>
<td>$U^m = 0.001$, $U^p = 0.995$</td>
</tr>
<tr>
<td>RMS – 7724.80</td>
<td>0.04</td>
<td>5.98</td>
<td>$U^m = 0.001$, $U^p = 0.995$</td>
</tr>
</tbody>
</table>

Derived from US Bureau of Transportation Statistics Data.
withdrew from the route and in the US, Frontier has difficulties. More evidence on the ability of competing low-cost carriers to recover costs is required.

References


