The Southwest Effect: A time series analysis on passengers carried by selected routes and a market share comparison.

D.E.Pitfield
Transport Studies Group
Department of Civil and Building Engineering
Loughborough University
Loughborough
Leicestershire LE11 3TU
UK
E-mail: D.E.Pitfield@lboro.ac.uk

Abstract

The Southwest effect has been known for some time in terms of the US airline's impact on pricing, competition and traffic volumes. But recent estimates of the impact on traffic and market shares do not exist. This desideratum can be addressed by applying Autoregressive Integrated Moving Average (ARIMA) models with Intervention analysis to key domestic air routes in the USA where Southwest has started service.

The paper first deals with the choice of routes to be examined and, after a preliminary statistical description of these, applies the ARIMA models. These results are examined for both their statistical qualities and their reasonableness and the impacts are compared to those previously determined in the same way for Ryanair's routes from London.

Keywords: Low-Cost Carriers, ARIMA Models, Intervention Analysis, Market Share.

JEL Classification Time Series Models C22, Transportation R40

1.0 Introduction

Previous published work (Pitfield, 2007a) has been able to demonstrate, using Autoregressive Integrated Moving Average (ARIMA) modelling with Intervention Analysis, what the impact of Ryanair's start up of service from London Stansted (STN) has been on competing airlines flying from other airports in the London system to either the same airport as Ryanair but more usually to an airport that is not thought of as a secondary airport. The impact is considerable. Passenger numbers grow on the route as a result of the start up and Ryanair at least captures that growth and normally has an impact on existing carriers by taking some of their share of the market as well.

Ryanair based its business model on one first developed by Southwest, originally based in Texas but now the sixth biggest airline in the USA (Calder, 2002) and the only US airline to have been profitable every year since its inception. The impact of Southwest on prices (Morrison, 2001) and its competitors is so well known it has long been referred to as 'the Southwest Effect' (USDOT, 1993; Richards, 1996) with evidence being seen at Baltimore-Washington International (BWI) Airport (Phillips, 1996) and again at Denver (DEN).[1] Boguslaski, Ito and Lee, (2004) investigate the entry patterns of Southwest and indicate airlines that might be vulnerable to such competition and McMullen and Du (2007) have investigated the impact of the ATA – Southwest code share.

However, there have not been any recent estimates on the impact on traffic. Estimates exist in the past papers of Windle *et al* (1995), Dresner *et al* (1996) and Vowles (2001). The first mentioned paper looked at data from 1991 to 1994 and found that the

[1] Airport Business (2006)

entry of Southwest onto a route resulted in an average price decline of 48 percent and a traffic increase of 200 percent on the Southwest routes whereas the second paper, which in part focuses on Southwest's start up at BWI in 1993, develops a general econometric model so as to comment principally on pricing behaviour. The third paper undertakes a series of airport case studies including one for BWI.

A current estimate of the intervention effect on passenger numbers of Southwest, its competitors or on total traffic on the routes will enable comparisons with past estimates and with the Ryanair impact previously determined. In addition, it will allow impacts to be determined for a much more mature market situation when the most recent start ups are examined.

USBTS Form 100 data is available online on a monthly basis from 1990 (BTS, 2006). This details origin-destination passengers carried between airports by airline and ARIMA models can be applied to this data before the start up of Southwest on routes when its impact can be estimated.

2.0 Data

The difficulty with this proposed approach, given the longevity of Southwest and its presence on many routes before 1990, is that the routes that can be examined are limited. Clearly, the start of Southwest service has to be after 1990 so that a time series model can be built before it intervenes. In addition, there is some credibility in the notion that 'important' routes should be looked at. In terms of passenger volume this can be based on the size of airports and Table 1 lists the ten busiest US airports. But this does not help much in terms of determining which city pair flows are 'important' or which could demonstrate the size of impact of Southwest on principal domestic traffic flows. An approach is taken here which first examines FAA data to identify city pairs in the 48 contiguous states that have a large number of flights between them as a guide to which city pairs should be examined in the BTS data to determine total passenger flows on corridors (see Table 2). This analysis is undertaken for 2005 and then candidate routes are examined. Some of these candidates represent flows between hub airports, for example Atlanta, Hartsfield (ATL) - Dallas/Fort Worth (DFW) and Chicago O'Hare (ORD) – Minneapolis St. Paul (MSP) and some represent flows between hubs and non-hubs, for example, ORD – Washington Reagan (DCA)[2].

A further aspect that should be covered is airport usage. Southwest often uses secondary airports, for example Chicago Midway (MDW) instead of ORD and BWI instead, at the time of the commencement of service, of the other Washington Airports, Reagan (DCA) and Dulles (IAD)[3]. There is an opportunity here to investigate its impact on major carriers flying the same corridor, but not using the secondary airports. Traffic on this Washington-Chicago corridor provides an opportunity to study this impact as Southwest started at BWI in September 1993 and was in competition with United and American as well as at various times American Eagle, US Airways and Northwest[4].

---

[2] Airline Hubs are listed by Oster Jr. and Strong (2006) but these are not in accordance with the FAA's definition of hubs and non-hubs which is based on the number of enplanements.

[3] By late 2006 Southwest was flying to MDW from IAD and ATA was code sharing with Southwest from DCA to MDW. Airline Weekly (2006) refers to ' Battling for the Capital'. DCA is capacity constrained and only handles domestic and Canadian trans-border flights of less than 1,250 miles.

[4] It might be hard to think of MDW as secondary as it is 10 miles from downtown Chicago whilst ORD is some 17 miles distant. Similarly, although BWI is 11 miles from downtown Baltimore it is only 33 miles from Washington DC whereas IAD is 25 miles distant with DCA closer at 5 miles.

Another route that can be examined is Philadelphia (PHL) to ORD as Southwest commenced service here in May 2004 and uses only one secondary airport (MDW not ORD) compared to the main competition from United, American and US Airways. Traffic from PHL to both ORD and MDW can be examined.

Further, the route between MDW and Providence, Rhode Island (PVD) has been operated by Southwest since October 1996. In addition, service has been offered from Manchester – Boston Regional Airport, New Hampshire (MHT) from June 1998. Both of these New England cities are promoted as Boston airports with one being recently renamed and both being about 50 miles from Boston. Of course Boston, Logan (BOS) is served by the major carriers who for much of the period were United and American. Although Chicago-Boston does not feature as a major city pairing from Table 2, it is clear that the inclusion of Providence and Manchester traffic brings it up to nearly 3 million in 2005 with some 170 flights scheduled in the summer period and so it is very worthy of study on any grounds of importance. Southwest is again using secondary airports at both ends of the route and there is the issue of their code share with ATA Airlines to explore.

Another route from Chicago Midway (MDW), where Southwest operates a number of services, is to Oakland, California (OAK). This is a secondary airport for San Francisco as the two cities are 13 miles apart on opposite sides of San Francisco Bay. This service officially started in April 2002. However, the BTS data records Southwest flights to OAK in most months and in most years since 1990 when the earliest available data is available online. Not only that, but there are also regular flights to San Francisco (SFO) recorded in the BTS data. Nevertheless, the volume of

Southwest traffic shows a sharp increase on the official commencement of service so the impact of this official start up on the Chicago (ORD and MDW) - Bay Area (SFO and OAK) can be examined. The main competitors are American on SFO-ORD, United on OAK-ORD and SFO-ORD along with ATA on SFO-MDW[5]. The overall route in 2005 carried just over 2.5 million passengers.

Finally, although the start up is very recent (January 2006), Denver (DEN) to Las Vegas (LAS) represents an opportunity to examine the impact when Southwest uses the same airports as its competitors. Competition here is with United, American West and Frontier Airlines, another low-cost airline. The previous work by Pitfield (2007a) would suggest that this impact would be greater than the case of one airport being shared with the competition and that this would be greater again than the case where Southwest uses two secondary airports. However, competition from another low-cost carrier, Frontier, may dilute this impact.

The other candidate routes in Table 2 either show that Southwest commenced service before 1990[6] or that it does not serve these airports as of mid-2006.

3.0 ARIMA Modelling

The formal method of ARIMA modelling and Intervention Analysis can be found in a variety of textbooks including Wei (1994) and McDowell et al (1980) and the published appendix to Pitfield (2007a) contains both an outline of this and of the assessment of goodness-of-fit.

---

[5] The impact of the ATA Southwest code share can again be investigated

[6] Otherwise it would be especially interesting to examine the impact on the traffic between the Bay Area (San Francisco, SFO and Oakland, OAK) to LAX first noted by USDOT (1993).

The purpose of ARIMA models is to duplicate as closely as possible the typical variations in a time series. Their adequacy is checked by examining both goodness-of-fit statistics and whether the residuals are white noise. If they are adequate, then the model will have captured all the indigenous factors that underlie the variation in the series being modelled. If such a model is calibrated on the traffic data before the commencement of Southwest service, then the same model form, plus an intervention variable, can be 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.

As the data series are monthly observations from 1990, it is clear that there will be both seasonal and non-seasonal components in the model. In essence, the series is forced to have a constant variance initially by taking a logarithmic transformation if required. Autocorrelation Function plots (ACF) and Partial Autocorrelation Function plots (PACF) are then examined at periodic lags of 12 months which can reveal any need for seasonal differencing. ACF and PACF plots are then inspected in the usual manner to reveal whether the seasonal model is autoregressive or moving average and how many parameters it should have. Parsimonious models are preferred. The residuals of this model are then investigated to determine, again using ACF and PACF plots, the form of the non-seasonal model. It is the overall residuals from this application that must be judged as white noise after examining the Box-Ljung Q statistics.

The intervention variable can take a variety of forms but intuitively it is easy to justify an abrupt step function because of the apparent impact of Southwest start ups on traffic volumes on routes[7]. In addition, if this start up coincides with other important exogenous influences, they would also have to be specifically examined and isolated. Although this conventional reason cannot be invoked for the routes studied here, it is interesting to examine the abrupt intervention impact on domestic propensity to fly of 9/11 and this is done.

4.0 Results

4.1 Washington-Chicago

Table 3 shows annual flows on the Washington-Chicago corridor. In the early 1990's United and American dominate the market with shares approaching or exceeding 90 percent. Southwest commences service in 1993 and in its first full year of operation, the total market grows by 18 percent. Southwest has nearly 11 percent of this market and the main incumbents share has fallen to below 80 percent. Southwest appears to increase and consolidate its share of a growing market until the late 1990's when it falls slightly. There is clearly an impact on traffic from 9/11 and the total market exceeds year 2000 levels again by 2004 with Southwest's share again reduced. These relative fluctuations appear to be a product of competition between the main carriers as well as American Eagle and ATA and the impact of the short-lived Independence Air. The commencement of Southwest service at IAD in late 2006 is also noteworthy. A monthly plot of the time series is shown in Figure 1 with the date of the BWI airline intervention indicated[8].

ARIMA modelling identification was based on the total traffic before September 1993 when Southwest started. The ACF and PACF plots of the stationary data, after taking

[7] This is also the argument advanced and tested in Pitfield (2007a).
[8] The 9/11 date is common to each graph and not specifically marked.

logarithms and regular and seasonal differencing, gives a (1, 1, 0) (2, 1, 0)12 model and this has white noise residuals. Applying this model form to the traffic from 1990 to 2006, including intervention variables to represent Southwest's start and 9/11, gives the results shown in Table 4. A less parsimonious model with an additional seasonal autoregressive parameter also did well but there is some doubt about the order of such a model (see McDowall et al, 1980).

The intervention variables show that Southwest expanded the traffic on the route by 19 percent, somewhat higher than its current annual market share but quite consistent with its initial impact[9]. The implication is that Southwest brought additional passengers to the route attracted by its low fares but that it had little impact on the traffic carried by competing carriers. Indeed, it may have lost some of its initial traffic to other airlines as they responded to the competition.

The 9/11 impact suggests a decline of over 50 percent. This impact is large but may be consistent with the findings of Blunk, Clark and McGibany (2006) on revenue passenger miles who argue that the impact of 9/11 is longer term and more permanent than industry analysts had first supposed. These revenue passenger mile figures would now be higher if you pose the counter-factual that 9/11 did not happen. The estimated impact also appears to be consistent with estimated impacts on some north Atlantic traffic (see Pitfield, 2007b).

The code share agreement in February 2005 with ATA produced no significant coefficients. Although the start of the IAD service is very recent it was also examined

[9] This estimate is far less than the impacts found in previous studies using quarterly data that looked at airports where Southwest operates but examining the total corridor is likely to show more modest impacts.

as was Independence Air. Neither had significant impacts with t values between 1 and 2 but their coefficients were positive and respectively 10 and 6 percent; the Southwest impact at BWI was not materially affected by the inclusion of these variables indicating robustness in the results.

4.2 Philadelphia-Chicago

Table 5 shows the annual traffic between PHL and both ORD and MDW. There is a step increase in the traffic when ATA offers service from MDW after 1998 and another large increase after 2003. This is probably in part a reaction to the disturbance to trends from 9/11 and the entry in May 2004 of Southwest. Both of these effects can be tested. In its first full year of operation, Southwest has 18.12 percent of the market and it grew to over 20 percent in 2006[10].

There is little to choose here between a (1,1,0) (2,1,0)12 ARIMA model and a (1,1,0) (3,1,0)12 alternative except for the parsimony of the former. On that basis although 9/11 is seen to have a large significant impact (-0.60), the start up of Southwest is not significant with a parameter estimated at 0.40 and t=0.63. Alternative specifications of the model appear to indicate quite robust estimates of the parameters. Neither intervention estimates or their significance changes very much. The results are shown in Table 6[11].

The results are surprising, but perhaps predictable. If the four months at the end of 2000 are compared to the four at the end of 2001, a near 20 percent traffic decline is observed. On that basis the 60 percent value for 9/11 may be an overestimate although

[10] Monthly data is plotted in Figure 2 and the start of service date indicated.
[11] A gradual intervention effect over 12 months did not improve the results.

as noted above, there is some work that suggests it should be less but not considerably so. The Southwest effect may be surprising, however, this is not a leisure route primarily and one of the airports used is secondary; both factors weighing against a larger impact. The raw data shows an immediate but short-lived upturn after May 2004 and it may be for this reason that the impact is not significant[12].

Monthly traffic for the main airlines on the route is shown in Table 7 from May 2004 to try and aid understanding. The total grows for the first three months, but in August, the traffic of United, US Airways and Southwest all fell. In September they were joined by American and ATA, with most making some recovery in October.

There is no large change in airline supply that explains these fluctuations either absolutely or relatively. Demand on this route generally fell in some months after May, so Southwest's impact on size, despite its growing share, does not register as significant. Despite the lack of significance of a market size effect, it is clear that Southwest itself thrived with a nearly 22 percent share of the market in 2006[13]. In other words, it did not expand the market size but it did take traffic from competitors.

4.3 Boston-Chicago

Looking at the annual traffic data in Table 8 shows the initially dominant position of United and American between these city pairs. Even after Southwest starts service between MDW and PVD in October 1996, it only captures 6.02 percent of the market in the first year of operation, although this of course represents a higher percentage of

[12] Again the ATA code share is not significant.
[13] There is a suggestion that Southwest might be competing with itself at Boston and Baltimore, but these alternatives offered service earlier, so it should be their traffic that is diluted on the start of the PHL service. In addition, at around 100 miles away it could be argued that they are too far distant.

the Chicago-Providence market alone. The next year service to MHT starts in June and at the year end Southwest's overall share is up to nearly 8 percent. It appears to do well in competition with American at PVD in the next year as American's share falls and Southwest's rises, however, in 2000 the major influence on shares is the significant arrival of ATA Airlines, another low-cost carrier, on the BOS-MDW route. 9/11 depresses overall traffic seemingly not influencing shares, however, the next major influence appears to be the influence of the code sharing agreement between ATA and Southwest in February 2005. After ATA filed for Chapter 11 bankruptcy protection, Southwest invested in ATA and upon their resulting exit from chapter 11, replaced ATA with code sharing flights on the Boston-Chicago Corridor using PVD and MHT as before.

This seems a very interesting route to study using ARIMA methods as both Southwest start ups can be examined for a significant intervention effect, along with 9/11 and the code sharing agreement. Figure 3 shows the time series plot. Not only are the start of service dates to PVD and MHT shown respectively, but so is the start of the ATA code sharing agreement.

Following the usual procedures, an autoregressive model of the usual form is fitted and this gives the results shown in Table 9. Neither the start up at PVD nor the later one at MHT are statistically significant as abrupt impacts but they do have the right signs and show an impact of 5.7 and 4.8 percent respectively[14]. The 9/11 impact is significant with a coefficient of -0.43. The ATA code share is omitted from the Table as it is insignificant.

[14] Varying model forms produces quite robust similar estimates and a gradual intervention again fails to produce significant results but suggests bigger impacts of 14 and 19 percent for PVD and MHT respectively.

These results, like those for Philadelphia – Chicago, imply that although the impact of Southwest on market size is insignificant, the fact that they have over 17 percent of the market in 2006 shows that they had an impact on the shares of their competitors, in this case, American, judging from Table 8.

4.4 Bay Area-Chicago

Table 10 shows the annual shares on the corridor with the early dominance of United and American. This position is maintained in the 21st century, but the relative position of these two airlines is weakened as can be seen from their falling shares. The figures for Southwest show a gradual impact on market share, followed by a boost in 2005 which may be the result of the ATA code share. This intervention can be tested along with the Southwest start up and 9/11. Figure 4 shows the monthly traffic data where some of the impacts discussed seem to be plain and others more obscure.

The usual procedures again yield a (1,1,0) (2,1,0) 12 model and the results are shown in Table 11 although there is a question mark over the character of the residuals with a spike at lag 36. Less parsimonious models can push this spike to greater lags but are questionable as model improvements. All show, however, the 9/11 intervention to be significant and sizable with the Southwest start up and the advent of code share insignificant. Specifying the Southwest intervention as a gradual one does not improve the result. As with the previous case, the implication, given their market share in 2006 of over 18 percent, is that this traffic largely came from their competitors.

4.5 Denver–Las Vegas

Traffic is dominated by United Airlines throughout this period from 1990. Southwest starts service in January 2006 and it can be seen from Table 12 that it took nearly 20 percent of the market in its first year. Figure 5 shows an abrupt upturn of traffic when it started. The intervention analysis can suggest what percentage Southwest's entry added to the market and this can be compared to its actual share.

Examining the monthly traffic data, it is clear that this route was impacted in a major way by the events of September 11th 2001. Traffic falls by some 33 percent between September and the end of the year but it recovers its pre 9/11 absolute levels of traffic by March 2002. Consequently in the ARIMA modelling it is essential to again include this impact and so a model was first developed that fitted the data from January 1990 to August 2001. After examining ACF and PACF plots, this is found to be a (1, 1, 0) (2, 1, 0)12 model. Applying this form to the series from January 1990 to December 2006, including binary intervention variables indicating immediate impact for 9/11 and the start of Southwest service, gives the model detailed in Table 13. The residuals of this model have insignificant Box-Ljung Q statistics, except marginally so at distant lags that even then do not have a concerning periodicity of 12. The residuals are white noise.

Of principal interest, the Southwest start up increased traffic on the route by 18 percent which is close to the market share of 19.42 percent actually achieved in 2006. Even in the first year of operation, Southwest may have taken some traffic from competitors. This impact reflects the relatively short period of service from Southwest and the presence of a competing low cost airline, Frontier. Both these factors pull the likely impact down. Contrary to this are the facts that the traffic is not between secondary airports and may well represent a majority of leisure traffic. These factors would both push the impact up.

The 9/11 parameter shows that traffic was negatively impacted by 41.8 percent. This degree of impact is consistent with the simple observation of the series and may well be in accordance with previous findings.

5.0 Conclusions

Similar ARIMA models are developed for each of the chosen corridors. The results show the significant impact of 9/11 in all cases and the significant impact on size of Southwest's start up in two of the five cases at around 20 percent. How do these impacts compare to those found in other empirical work? Are these results in accordance with past work?

Table 14 illustrates the paradigm of interpretations of effects giving the datum of market share and the estimated impact on size. It shows that Southwest is in the last two rows of the Table either taking traffic entirely from competitors, as its entry does not grow the market, or growing the market and keeping that traffic. Ryanair is in the first category where it grows the market and takes share from competitors. It has significant and often larger impacts from market entry.

The impact of Southwest is less than that found for the majority of routes examined in Pitfield (2007a) for Ryanair. Exceptions are Stockholm and Hamburg's start up impacts. These are lower and of the order of 10 percent and these might be argued to be comparable to the Southwest routes in terms of scale and market segment but the impacts on Venice, Pisa and Genoa were estimated at 26, 30 and 44 percent respectively. What reasons can be used to explain this difference?

First of all, the Italian destinations analysed are more likely to be dominated by leisure traffic than the US cases, with the exception of Las Vegas. However the Las Vegas service has only been in place for just over a year so it may be too early to assess the true long term impact of Southwest.

Second, the number of carriers on the routes is higher in the US cases than the European and the scale of traffic is considerably higher on all corridors except London – Stockholm.

Third, Ryanair, with its frequent offerings of flights at £0.01, as they still appear on the website excluding taxes and charges, may be a more aggressive competitor. However an examination of fares being offered on two routes with similar stage length, four months from the time of writing (August 3rd 2007) shows that the Ryanair return fare with all taxes and charges was £118 or $217 whereas the Southwest promotional fare was $246 or £134. In this case Ryanair is only fractionally cheaper so its ‘normal’ fares don’t indicate any competitive edge but its reputation and its non-inclusive fares may.

For all these reasons, it might be concluded that Southwest, when it has significant effects, has a smaller initial impact than Ryanair but that Ryanair establishes larger market shares as a result of its impact on competitors. It appears that the major US competitors are more competitive than most of Ryanair's competitors in maintaining share through pricing and product differentiation.

Finally, the explanation for the different estimates might be based on the different levels of network maturity and familiarity with low-cost service and this topic could be approached empirically using Gini coefficients (Huber, 2005). This might be why the Ryanair impacts are higher than the Southwest impacts established using the same time series methodology.

As for the comparison with the previous estimates for Southwest, focussing on the change in traffic at the airports where Southwest operates, the approach previously used, is likely to give more dramatic impacts than when the whole corridor is examined in what Vowles (2001) might call routes between multi-airport regions and the estimated impacts are in keeping with the simple examination of the data.

References

Airline Weekly (2006), Battling for the Capital: Airlines fight fiercely for profits at Washington's three airports, 108, September.

Airport Business, (2006) available at http://www.airportbusiness.com/article/article.jsp?siteSection=&id=7345

Blunk, S., Clark, D.E. and J.M. McGibany, Evaluating the long-run impacts of the 9/11 terrorist attacks on US domestic airline travel, *Applied Economics*, 38, 363-370.

Boguslaski, C., Ito, H. and D.Lee, (2004), Entry Patterns in the Southwest Airlines Route System, *Review of Industrial Organization,* 25, 317-350.

BTS, (2006), Air Carrier Statistics (Form 41 Traffic) T:100 Domestic Market Data, Bureau of Transportation Statistics, available from http://www.transtats.bts.gov/Field.asp?Table_ID=258

Calder, S. (2002), *No Frills: The truth behind the low-cost revolution in the skies*, Virgin Books, London.

Dresner, M., Jiun-Sheng Chris Lin and Windle, R. (1996). The Impact of Low-Cost Carriers on Airport and Route Competition, *Journal of Transport Economics and Policy*, 30, 309-328.

Huber, H. (2005). Getting competition right in air traffic: New ways of assessing market structure and concentration among airline networks. Paper presented to International Organization Conference, Georgia Tech., Atlanta, USA. Available at http://www.eiasm.org/documents/JMW/cv/106.pdf

McDowall, D., McCleary, R., Meidinger, E.E. and R.A Hay (1980): *Interrupted Time Series Analysis*, Sage publications, Beverley Hills.

Morrison, S. (2001), Actual, Adjacent and Potential Competition: Estimating the full effect of Southwest Airlines, *Journal of Transport Economics and Policy*, 35, 239-256.

McMullen, B.Starr and Du, Y, (2007) The Economic Impact of the ATA/Southwest Airlines Code Share Alliance. Paper presented to the 48th Annual Transportation Research Forum, Boston University, March 15th-17th, Boston, USA.

Oster Jr., C.V. and Strong, J.S., (2006) The Evolution of US Domestic Airline Route Networks since 1990. *TRB Annual Meeting CD-ROM*.

Pitfield, D.E., (2007a). Ryanair's impact on airline market share from the London area airports: a time series analysis, *Journal of Transport Economics and Policy*, 41, 75-92.

Pitfield, D.E. (2007b). The impact on traffic, market shares and concentration of airline alliances on selected European – US routes, *Journal of Air Transport Management*, 13, 192-202.

Phillips, E.H. (1996). Access, low-cost airlines spur record BWI traffic. *Aviation Week & Space Technology*, 144, pp34-6.

Richards, K. (1996). The effect of Southwest Airlines on U.S. airline markets, *Research in Transportation Economics*, 4, pp.33-47.

USDOT, (1993), The Airline Deregulation Evolution Continues: The Southwest Effect, Office of Aviation Analysis, available from http://ostpxweb.dot.gov/aviation/X-50%20Role_files/Southwest%20Effect.DOC.

Vowles, T.M. (2001). The “Southwest Effect” in multi-airport regions, *Journal of Air Transport Management*, 7, 251-258.

Wei, W.S. (1994). *Time Series Analysis: Univariate and Multivariate Methods*, Addison-Wesley, Redwood, CA.

Windle, R.J. and Dresner, M.E. (1995). The short and long run effects of entry on U.S. domestic air routes, *Transportation Journal*, 35, 14-26.

Table 1: Top Ten US Airports by Total Passengers, 2005

Airport	Total passengers
Atlanta, Hartsfield(ATL)	85,907,423
Chicago, O'Hare(ORD)	75,510,003
Los Angeles(LAX)	61,485,269
Dallas/Ft.Worth(DFW)	59,064,360
Las Vegas(LAS)	44,280,190
Denver(DEN)	43,307,335
Phoenix, Sky Harbor(PHX)	41,204,071
New York(JFK)	40,584,001
Houston(IAH)	39,713,920
Minneapolis/St.Paul(MSP)	37,563,664

Source: Derived from http:/infoplease.com/ipa/A0004547.html

Table 2: Passenger Flows between Airport Pairs, 2005

Airport Pairs	2 way passenger traffic 2005	Approx summer period flights per day
Los Angeles(LAX)-Las Vegas (LAS)	2,423,208	68
New York La Guardia (LGA)-Chicago O'Hare (ORD)	2,289,646	71
ORD-LAX	2,285,468	45
LGA- Atlanta Hartsfield (ATL)	2,248,702	59
New York John F Kennedy (JFK)-LAX	2,216,267	58
ATL-Dallas Fort Worth (DFW)	2,212,884	64
LAS-Phoenix Sky Harbor (PHX)	2,049,611	63
Minneapolis St. Paul (MSP)-ORD	1,693,561	64
ATL-Newark (EWR)	1,680,416	53
LAX-San Francisco (SFO)	1,559,803	64
Philadelphia (PHL)-ORD	1,568,039	44
Denver (DEN)-LAS	1,473,479	51
Boston Logan (BOS)-LGA	1,465,546	83
ORD-Washington Reagan (DCA)	1,447,809	52
DCA-LGA	1,369,460	80
Houston (HOU)-Dallas (DAL)	1,231,220	65

Based on BTS Form 41 traffic data at
http://www.transtats.bts.gov/Fields.asp?Table_ID=258
and FAA data on flights at http://www.apo.data.faa.gov/main/

Table 3: Washington – Chicago Corridor 1990 – 2006

Year	Total Pax	Southwest %	United Airlines %	American Airlines %
1990	2,375,112		60.44	24.44
1991	2,393,607		66.03	21.67
1992	2,511,298		68.81	27.34
1993	2,755,761	2.73*	67.77	24.43
1994	3,263,068	10.77	58.71	20.79
1995	3,211,786	14.76	54.03	20.90
1996	3,194,699	15.72	57.48	18.93
1997	3,124,296	15.98	58.13	19.13
1998	3,342,934	13.88	60.68	17.88
1999	3,401,489	13.58	59.80	13.40
2000	3,568,048	13.55	52.66	19.59
2001	3,195,510	14.85	53.96	21.24
2002	3,250,954	13.99	56.19	21.97
2003	3,408,891	13.63	56.77	19.96
2004	3,712,138	10.67	55.62	19.59
2005	3,927,290	10.55	52.29	19.82
2006	3,773,597	13.50	56.72	13.65

*part year

Derived from BTS Data

Table 4: Washington-Chicago Results

	Parameters	t tests	Goodness of Fit
AR1	-0.17	-2.54	SE=0.06
SAR1	-0.62	-8.60	Log Likelihood=253.21
SAR2	-0.22	-3.00	AIC=-496.43
9/11 Intervention	-0.56	-10.29	SBC=-480.17
SWest Intervention	0.19	3.54	
RMS=15517.17	U=0.03	U^M=0.01	U^S= 0.00 U^C=0.99

Table 5: Philadelphia – Chicago Corridor 1990 – 2006

Year	Total Pax	Southwest %
1990	1,245,537	
1991	1,131,277	
1992	1,024,024	
1993	1,076,295	
1994	1,221,128	
1995	1,101,345	
1996	1,134,167	
1997	1,202,547	
1998	1,214,754	
1999	1,309,552	
2000	1,436,632	
2001	1,368,553	
2002	1,530,130	
2003	1,497,428	
2004	1,876,068	7.15*
2005	1,920,027	18.12
2006	1,873,505	21.67

*part year

Derived from BTS Data

Table 6: Philadelphia-Chicago Results

	Parameters	t tests	Goodness of Fit
AR1	-0.20	-3.26	SE=0.09
SAR1	-0.57	-7.89	Log Likelihood=225.17
SAR2	-0.23	-9.57	AIC=-440.34
9/11 Intervention	-0.60	-9.57	SBC=-424.08
SWest Intervention	0.04	0.63	
RMS=8299.27	U=0.04	U^M=0.00	U^S= 0.03 U^C=0.98

Table 7: Philadelphia – Chicago Traffic by Airline and Month from May 2004

	American	ATA	Southwest	United	US Airways	Total
May	37,414	26,910	12,999	59,341	31,734	168,398
June	44,960	26,649	18,338	60,712	40,764	191,423
July	43,971	28,766	19,325	61,640	40,408	194,110
August	45,271	30,978	18,397	57,855	37,656	190,157
September	39,119	21,519	15,225	48,744	34,083	158,690
October	45,020	23,468	16,750	49,939	39,369	174,546
November	41,458	19,194	16,885	48,474	36,548	162,559
December	38,973	17,462	16,287	46,321	32,214	151,257

Table 8: Boston – Chicago Corridor 1990 – 2006

Year	Total Pax	Southwest %	United Airlines %	American Airlines %
1990	1,851,286		53.57	35.14
1991	1,864,459		55.05	34.10
1992	1,757,672		57.15	40.24
1993	1,810,847		56.15	39.59
1994	1,918,401		55.86	39.47
1995	1,968,585		53.13	42.71
1996	2,073,424	1.14*	52.32	44.66
1997	2,311,873	6.02	51.06	41.39
1998	2,572,384	7.85**	51.68	39.59
1999	2,657,353	11.76	52.77	35.03
2000	2,733,033	11.11	47.93	35.62
2001	2,605,881	10.14	47.47	33.43
2002	2,746,546	9.18	50.02	32.51
2003	2,903,620	10.12	48.91	31.60
2004	2,959,571	9.42	45.35	34.93
2005	2,961,009	12.97	44.22	33.30
2006	2,853,015	17.22	46.09	26.98

* part year of PVD start
** part year MHT start

Derived from BTS Data

Table 9: Boston-Chicago Results

	Parameters	**t tests**	**Goodness of Fit**
AR1	-0.21	-3.21	SE=0.06
SAR1	-0.46	-6.13	Log Likelihood=269.14
SAR2	-0.21	-2.83	AIC=-526.29
9/11 Intervention	-0.43	-8.63	SBC=-506.77
SWest Intervention PVD	0.06	1.15	
SWest Intervention MHT	0.05	0.98	
RMS=11693.17	U=0.03	U^M=0.00	U^S=0.02 U^C=0.99

Table 10: Bay Area – Chicago Corridor 1990 – 2006

Year	Total Pax	Southwest %	UA %	AA %
1990	1,933,590		72.74	25.75
1991	1,904,656		73.72	24.47
1992	2,111,897		72.72	26.62
1993	2,043,722		74.33	24.84
1994	2,135,456		74.67	23.69
1995	2,211,022		69.75	25.52
1996	2,354,136		70.46	24.07
1997	2,393,423		69.65	23.88
1998	2,458,742		69.03	23.01
1999	2,397,362		67.97	22.02
2000	2,404,513		64.85	22.48
2001	2,251,178		64.88	21.15
2002	2,547,989	6.21*	62.34	18.58
2003	2,736,346	8.20	60.33	17.69
2004	2,778,735	8.44	58.47	17.32
2005	2,511,592	16.22	55.15	20.89
2006	2,370,150	18.43	58.56	21.04

* part year

Derived from BTS Data

Table 11: Bay Area-Chicago Results

	Parameters	t tests	Goodness of Fit
AR1	-0.21	-3.20	SE=0.06
SAR1	-0.42	-5.71	Log Likelihood=260.65
SAR2	-0.20	-2.60	AIC=-511.30
9/11 Intervention	-0.45	-8.85	SBC=-495.03
SWest Intervention	0.04	0.68	
RMS=11868.89	U=0.03	U^M=0.00	U^S= 0.03 U^C=0.97

Table 12: Denver– Las Vegas 1990 – 2006

Year	Total Pax	Southwest %
1990	695,184	
1991	714,951	
1992	822,614	
1993	826,153	
1994	913,569	
1995	847,131	
1996	978,405	
1997	966,317	
1998	892,906	
1999	1,079,639	
2000	1,104,609	
2001	1,051,445	
2002	1,043,382	
2003	1,212,509	
2004	1,347,436	
2005	1,473,479	
2006	1,955,090	19.42

Derived from BTS Data

Table 13: Denver- Las Vegas Results

	Parameters	t tests	Goodness of Fit
AR1	-0.24	-3.39	SE=0.08
SAR1	-0.60	-8.44	Log Likelihood=203.87
SAR2	-0.31	-4.26	AIC=-397.74
9/11 Intervention	-0.42	-5.97	SBC=-381.48
SWest Intervention	0.18	2.17	
RMS=7724.80	U=0.04	U^M=0.00	U^S= 0.01 U^C=0.99

Table 14: Paradigm of Interpretation of Impacts on Market Share and Size

Market Share x % (Datum)	Impact on Size y % (Estimate)	Interpretation
x >	y	Grew market and took traffic from competitors e.g. Ryanair
x <	y	Grew market but failed to hold share e.g. GO
x =	y	Grew market and retained market share. Little impact on competitors shares e.g. new markets? – Southwest, Washington-Chicago
x	y Insignificant	Did not grow market so took share from competitors e.g. Southwest – Philadelphia-Chicago

Figure 1: Washington-Chicago Monthly Traffic 1990-2006

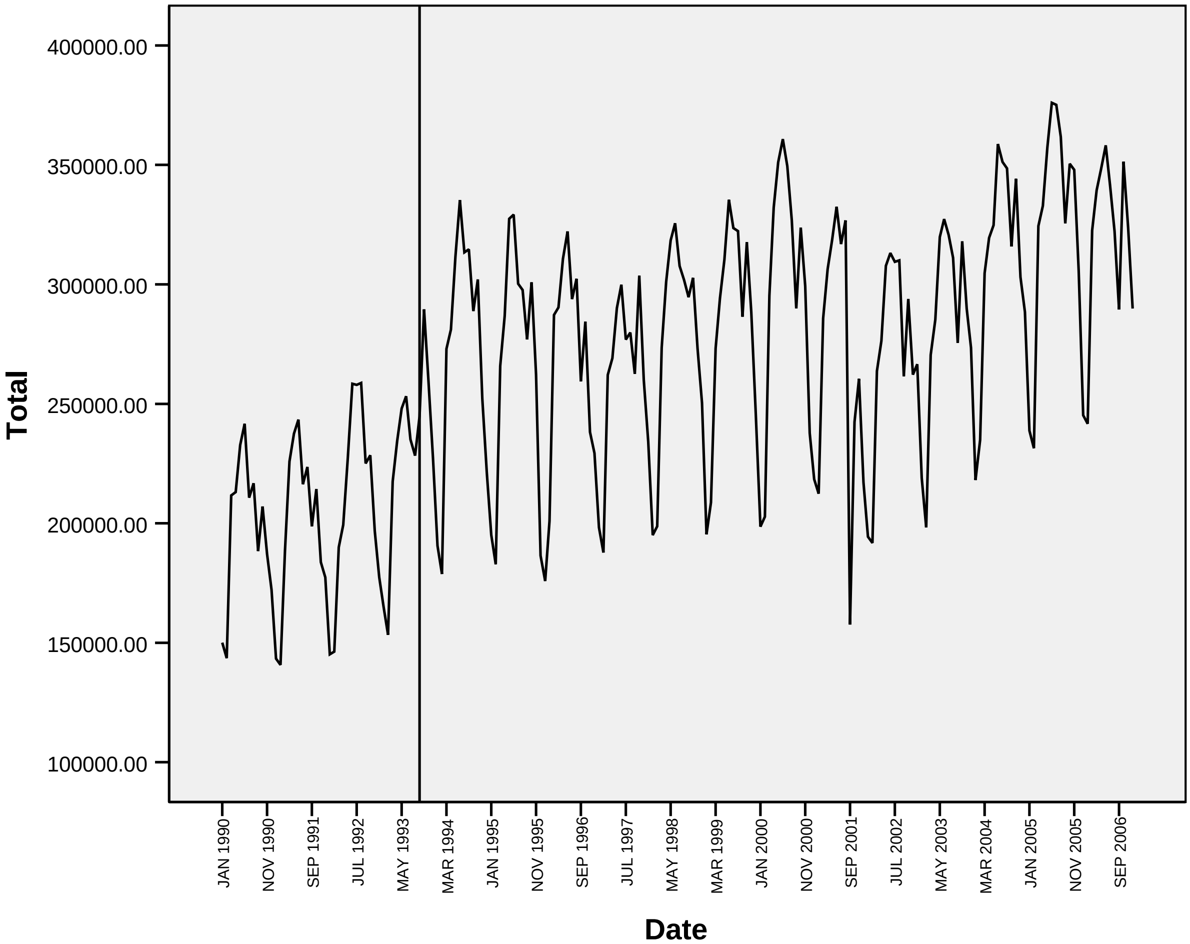

Figure 2: Philadelphia-Chicago Monthly Traffic 1990-2006

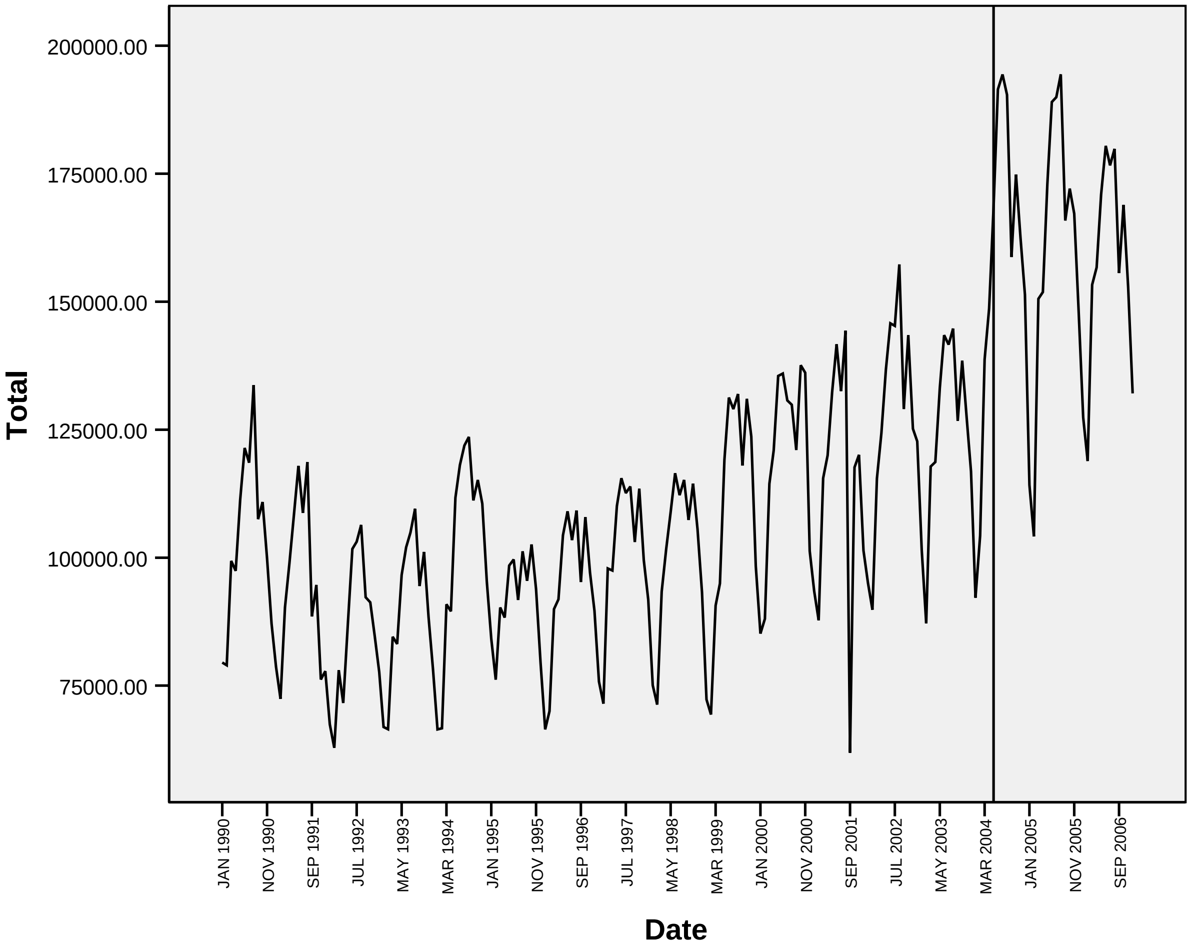

Figure 3: Boston-Chicago Monthly Traffic 1990-2006

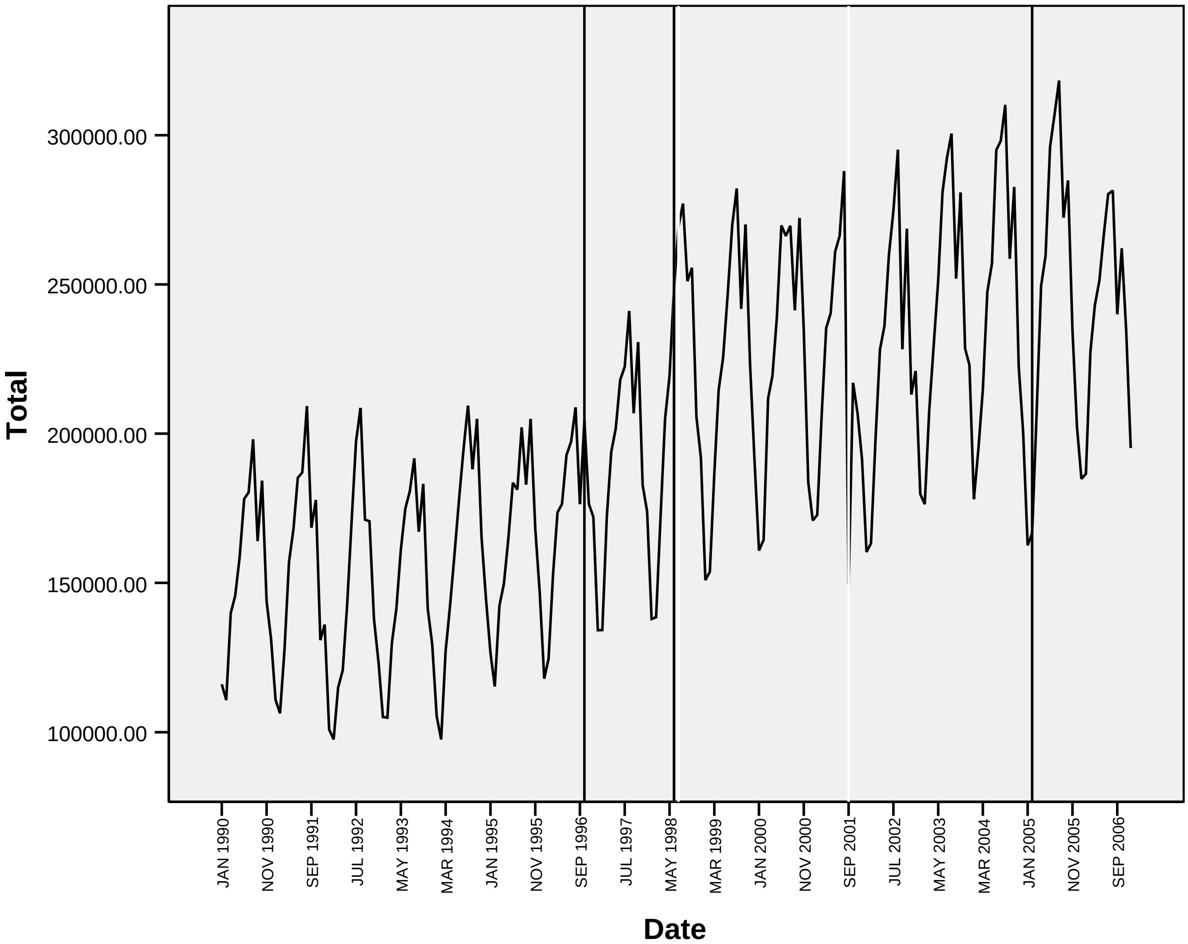

Figure 4: Bay Area-Chicago Monthly Traffic 1990-2006

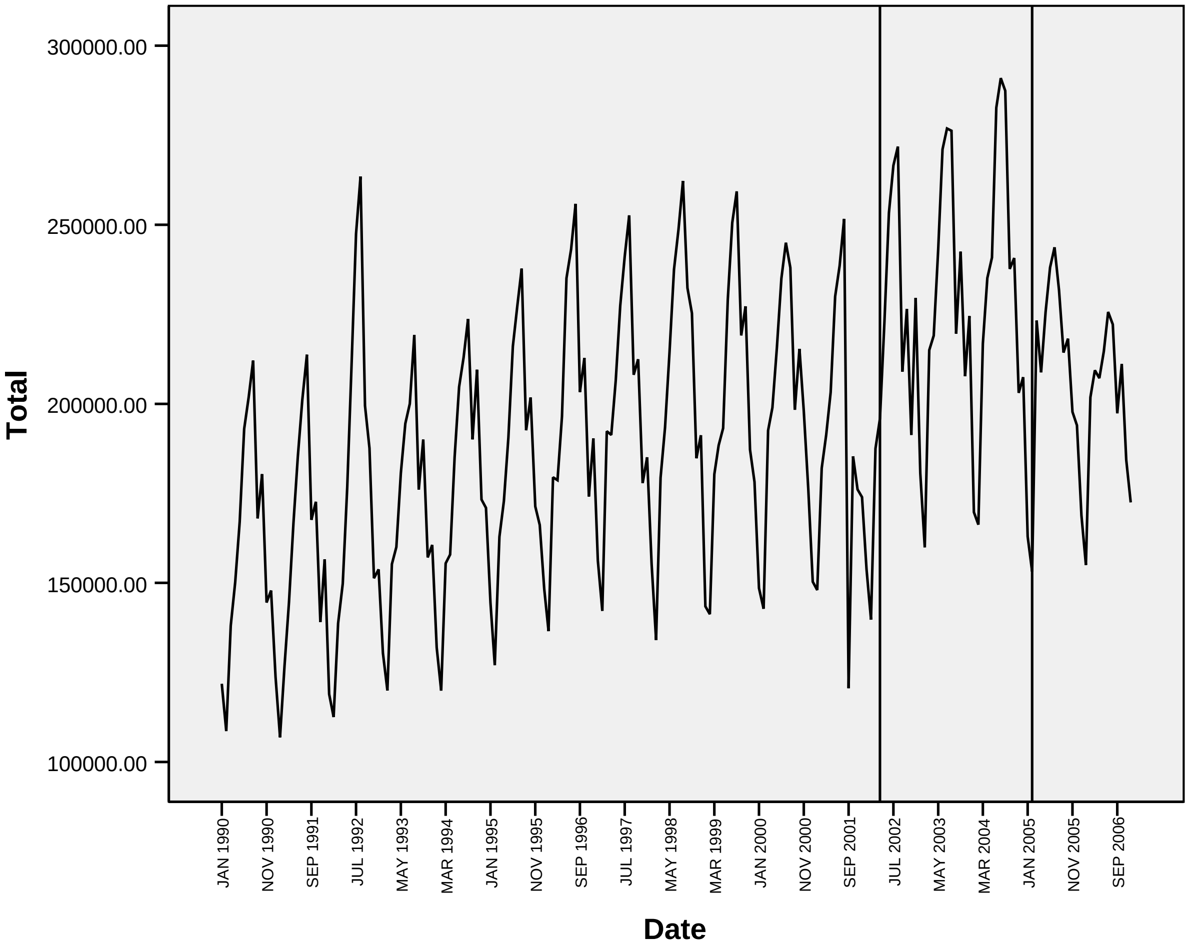

Figure 5: Denver–Las Vegas Monthly Traffic 1990-2006