Bilotkach V, Mueller J, Nemeth A. [Estimating the consumer welfare effects of de-hubbing: The Case of Malév Hungarian Airlines](#). *Transportation Research Part E: Logistics and Transportation Review* 2014, 66, 51-65.

Copyright:

© 2014. This manuscript version is made available under the [CC-BY-NC-ND 4.0 license](#)

DOI link to article:

<http://dx.doi.org/10.1016/j.tre.2014.03.001>

Date deposited:

21/04/2016

Embargo release date:

18 September 2015

This work is licensed under a
[Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International licence](#)

Consumer welfare effects of de-hubbing:

Case of Malév bankruptcy

August 2013

Volodymyr Bilotkach¹
Newcastle University

Juergen Mueller
HWR-Berlin

Adél Németh
UAS Bremen and Jacobs
University Bremen

Abstract

We document and analyze the events that followed bankruptcy of Malév Hungarian Airlines on February 3, 2012. As this network carrier ceased its operations; point-to-point low-cost airlines (most notably, Ryanair and Wizzair) expanded their presence at the former hub. Data analysis demonstrates that, other things equal, low-cost point-to-point carriers are more likely to enter on short-haul routes to destinations with higher-income passenger base. Frequency of service offered by point-to-point carriers is lower than what was offered by the network airline. Specifically, Ryanair enters with half as many flights as Malév operated prior to bankruptcy; whereas Wizzair offers only a third of Malév's frequency, other things equal. As passengers are likely to benefit from lower prices charged by point-to-point carriers, but suffer from lower frequency at the same time; we suggest a methodological approach to analyze the corresponding trade-off, and apply it to our data. We conclude that passengers flying to seven out of eighteen former Malév destinations where point-to-point carriers entered might be worse off despite potentially paying lower prices. Overall, the bankruptcy event likely adversely affected passengers on twenty former Malév markets, which retained non-stop service to Budapest.

¹ Corresponding author. Senior Lecturer in Economics, Newcastle University. Email: Volodymyr.Bilotkach@Newcastle.ac.uk; phone: (+44)1912281648. We thank conference participants in Paris, Bergamo and Palermo for constructive comments. Adél Németh thanks Erich-Becker-Foundation for support.

I. Introduction

On February 3, 2012, Malév Hungarian Airlines grounded all its aircraft, and discontinued its operations after the Hungarian government stopped funding the loss-making carrier following the European Commission's finding such support to be illegal. This event marked the end of the airline's 66-year history. Budapest Ferihegy² International airport has lost its position in the list of the world's hub airports, and is unlikely to regain this status in the near future. Two of Europe's leading low-cost carriers (Ryanair and Wizzair) have immediately announced their plans to launch new services out of Ferihegy. Nevertheless, as of the end of the summer of 2012, non-stop services to fourteen destinations out of Budapest have been lost.

Unfortunate as it was, the Malév bankruptcy event, along with the subsequent developments, offer us a very interesting opportunity to address the issue of importance and value of hub operations. Rapid growth of low cost carriers (LCCs) at Budapest airport post-bankruptcy allows us to approach the questions of both determinants of European LCC entry, and the value of European low-cost airlines' point-to-point services as opposed to the network provided by the now bankrupt Malév. Indeed, some commentators suggested after bankruptcy that carriers like Wizzair and Ryanair would be capable of replacing Malév. This claim, however, does not take into account the following important considerations. By virtue of offering a hub-and-spoke network, the hub operator was probably capable of providing higher frequency of service as compared to what the replacement flights by LCCs would offer. This raises the question of whether passengers on those routes are adequately compensated for lower frequency of service by the supposedly lower fares offered by the LCCs. This study offers a first empirical exercise of this kind, applying valuations of frequency of service, reported in the stated-preference studies.

Further, some of the routes could lose non-stop services altogether, and Malév's former partner airlines might be forced to curtail their services to Budapest, as they would no longer be able to fill up their flights with transfer passengers to feed Malév's network. This consideration is especially important in light of Bel and Fageda's (2008) finding that corporations prefer locating at areas, well connected to the rest of the world with non-stop air services. Also, the airport might find itself in a situation of having to deal with excess capacity, which effectively represents specific assets, requiring a hub operator to be used. Finally, passengers that used to rely on Malév to connect to services of the carrier's larger oneworld alliance partners have now lost this option.

In addition to the above considerations, understanding the developments that followed Malév's bankruptcy is important for the following reasons. First, several other Eastern European flag carriers are currently finding themselves in a rather precarious financial situation, indicating that further bankruptcies may be possible³. Second, European airline market appears to be developing towards a unique model, with network carriers co-existing with the LCCs providing point-to-point services at low fares. It will therefore be interesting to understand, to what extent LCCs can pose a threat to the network carriers' networks, for instance through cream skimming. Third, as further consolidation in the global airline industry appears certain; we are likely to see further cases of de-hubbing. Our research thus informs the European hub airports about what they can expect when their hub operator leaves. In particular, it will be important for the airport

² After March 2011 the new name of the airport is Liszt Ferenc international.

³ In fact, Aerosvit Ukrainian Airlines bankruptcy in January 2013 represents another recent case of disappearance of a hub operator.

operator to understand and evaluate the extent, to which the airport capacity may represent specific assets, for which there will be no use should the hub operator depart.

Results of our data analysis demonstrate the following. First, simple comparison of summer 2011 versus summer 2012 schedules shows that Budapest airport lost almost quarter of its scheduled flights; however, the number of seats offered by scheduled airlines declined by only 8.6 percent. Non-stop services to fourteen cities have been discontinued. At the same time, services to 22 new airports have commenced (which however translates into services to only eleven cities that have previously not been connected with Budapest by scheduled non-stop flights⁴). Further data analysis shows that, controlling for various market characteristics and at the city-pair market level, Ryanair offers about half as many flights as Malév did in the summer of 2011. The corresponding figure for Wizzair is about one third. This increases the disutility of schedule delay for the passengers – a measure especially relevant for the business travelers. Analysis of the new and discontinued destinations and services reveals no surprises. Infrequent services to lower-income destinations were lost, whereas new services are usually short-haul flights to higher population higher income areas. Higher number of Malév flights before bankruptcy is also associated with a higher probability of a new service out of Budapest airport post-bankruptcy. Finally, we have detected an interesting difference in the entry strategies of Ryanair and Wizzair. While Ryanair appears to target higher-income cities that have been generally underserved prior to Malév's bankruptcy; Wizzair's strategy is focused more on replacing Malév's services to higher-income destinations.

We are also able to shed light on the price-frequency trade-off, which inevitably arises as point-to-point carriers that replace a network hub operator will offer less frequent services at lower prices. Using previously reported (Lijesen, 2006) studies of passenger valuation of frequency; we are able to derive the implied price reductions, required to compensate the passengers for lower frequency of service. Applying these to our data, we are able to identify several instances, where replacement of the network airline with a low-cost point-to-point carrier has most likely made passengers worse off. To our knowledge, this is the first time such an exercise – applying stated-preference based estimates of disutility of schedule delay to actual data – is reported in the literature.

Overall, our study offers a unique and novel perspective at the issue of de-hubbing, as well as at the question of the value of networks. The most closely related study to ours is Redondi *et al.* (2012), which documents the instances of de-hubbing worldwide, demonstrating that former hub airports never fully recover in terms of traffic volumes they have had prior to losing their hub status. Bilotkach *et al.* (2012) also demonstrate that de-hubbing leads to lower aeronautical fees charged by the airports.

Entry in the airline industry has been studied by Berry (1992), Dunn (2008), Joskow *et al.* (1994), Lin *et al.* (2002), Oliveira (2008), Reiss and Spiller (1989), Sinclair (1995), Goolsbee and Syverson (2008). Most of these studies deal with the US market, but some pay specific attention to low-cost carriers. The issue of LCC network development, which is also relevant to this work, has been also studied on the US market. Notable contributions here include Boguslaski *et al.* (2004) and Mueller *et al.* (2012). The issue of access to airport facilities as a determinant of market power in the airline industry is covered in Ciliberto and Williams (2010). Looking at the effects of network versus point-to-point carriers on regional development, Alderighi and

⁴ We will discuss our definitions of airport-pair markets versus the city-pair markets later on.

Gaggero (2013) suggest that increased frequency of the former but not the latter has positive effect on exports out of Italy's regions.

Overall, the existing literature covers issues that are related to the proposed study; however, EU markets remain understudied, and the existing body of work is silent on the issue of the value of hub operator's network for the residents of the corresponding area. These are the two gaps in the literature we are starting to fill with this work.

II. Malév Bankruptcy and Consumer Welfare – Preliminaries

Prior to bankruptcy, Malév held a clearly dominant position at Budapest Liszt Ferenc International airport (IATA code BUD). In particular, in the summer of 2011, Malév performed nearly half of all scheduled departures out of this gateway, offering non-stop services to 51 destinations in Europe and the Middle East. BUD served as the only hub in Malév's network, which the carrier used to channel passengers from Eastern Europe and the Middle East to the Western European destinations.

The impact of Malév bankruptcy on consumer welfare will, in general, depend on how other carriers will have reacted to disappearance of the hub operator. Generally speaking, we can offer the following classification of Malév routes based on what may happen after the bankruptcy event.

1. Malév leaves a route, where it was the only carrier, and no one replaces this airline. Thus, a route loses all the service. Fourteen endpoints, as of the summer of 2012, fall into this category. While passengers can still get from their origin to BUD via a connecting service; the new alternative implies a substantial increase in travel time, and potentially in the total cost of travel.
2. Malév leaves a route, where it was the only carrier, and an LCC enters. There were 26 airports, where MA was the only carrier offering the service. After the merger, Wizzair entered eight such markets; Ryanair started its services on three; and Air Berlin entered one route.
3. Malév leaves a route, where it was the only carrier, and a legacy carrier enters. We only have two such cases: Lufthansa started flying to BUD from Hamburg (flights operated by Eurowings – a Lufthansa-owned subsidiary) and Berlin (as of April of 2013, Lufthansa is no longer serving this destination from BUD).
4. Malév leaves a route, where it operated with a legacy carrier, and the legacy carrier expands its service. A number of such cases are present in our data: Aeroflot, Air France, Austrian Airlines and Finnair are among the carriers that expanded their services to Budapest from their hubs following the bankruptcy of Malév. The resulting frequency tends however to be lower than the total frequency of service by Malév and the corresponding legacy carrier before the bankruptcy.
5. Malév leaves a route, where it operated with a legacy carrier, and an LCC enters this route. Some cases of this kind are observed as well, including Dublin and Warsaw.
6. Malév leaves a route, where it operated with an LCC, and LCC expands its service. Wizzair did this on seven separate markets (Ryanair was not present at BUD in the summer of 2011 – the time period to which our pre-bankruptcy data refers).

In either case, understanding the consumer welfare implications of the hub operator bankruptcy involves evaluating likely changes in prices and frequency of service. As we will discuss more formally later in this paper, both decrease in frequency of service and increase in price will have

adverse effects on consumer surplus. This will be an especially important consideration when assessing the welfare effects on routes, where Malév is 'replaced' by an LCC.

Since legacy (or network) carriers follow a business model, which is quite similar to the one Malév practiced; welfare effects of these airlines' reaction to Malév's bankruptcy are quite easy to understand. On a number of markets, competition decreased, along with total frequency of service, so that passengers are likely paying higher fares on the respective routes. At the same time, passengers have obtained better access to the networks of the corresponding network carriers, with potentially more connections at the respective hubs.

Possible welfare effects on the routes, where Malév's bankruptcy led to either entry or expansion of low cost carriers' services deserve a more detailed discussion, due to the peculiar nature of the LCCs business models. The main low-cost airline players in the Malév bankruptcy story are Wizzair and Ryanair. Wizzair is a Hungarian low-cost carrier, which has established itself as the leading LCC in Eastern Europe. Wizzair has directly competed with Malév on a number of routes prior to the network carrier's bankruptcy.

Based in Ireland and operating a fleet of over 300 aircraft, Ryanair is the largest LCC in Europe. In February of 2012, Ryanair was in the process of entering Budapest. Upon hearing about Malév bankruptcy, the airline almost immediately announced a considerable expansion at BUD, a plan to serve over 20 destinations out of this airport instead of originally announced six. A third major European low cost carrier – easyJet – did not respond to this bankruptcy event in any appreciable way, leaving its frequencies out of the airport essentially intact.

Both Ryanair and Wizzair operate very similar business models, which include: strictly point-to-point operations⁵, strictly non-refundable fares, fees for checked luggage and substantial restrictions on carry-on luggage allowance, absence of frequent flier programs, absence of assigned seating (and fees for the right to select a specific seat), extensive use of smaller remote airports, and single aircraft-type fleet (Ryanair operates a fleet of Boeing-737 aircraft, while Wizzair's fleet consists of Airbus A-320 airplanes). Absence of connecting operations most clearly differentiates these carriers from both European network airlines such as Malév, and the US low cost carriers. Some commentators indeed suggested that Wizzair and Ryanair could replace Malév after the bankruptcy. However, low-cost carriers' reliance on point-to-point services will mean that the airlines will likely offer less frequent flights. Use of remote airports and absence of flexible refundable fares can create additional inconvenience for business travelers.

In transport economics, it is common to think about the total cost of travel as consisting of the price of transportation and the value of travel time. An important component of the latter is the concept of schedule delay – the difference between the passenger's preferred departure time and the actual time the flight departs. Generally speaking, the schedule delay is inversely proportional to the flight frequency on the route. Therefore, any event that lowers flight frequency increases the total cost of the trip for a representative traveler.

Losses due to potential higher disutility of schedule delay can be counterweighted by the gains due to potentially lower fares with the expansion of low cost carriers. Coupled with the use of remote airports, however, lower fares may not mean lower total cost of travel, which could be

⁵ Any passenger wishing to connect from one flight to the next must purchase two separate tickets. The airlines will not be responsible for any missed connections, irrespective of the reason.

especially relevant for business travelers. For instance, arrival to Charleroi airport (used by Ryanair as an alternative to Brussels airport) would imply an additional hour to get to/from Brussels city center – the value of this time to the traveler has to be therefore incorporated into calculation of the total cost of the trip.

In addition to losses due to higher disutility of schedule delay, bankruptcy of Malév has reduced competition on one-stop routes from Eastern Europe and the Middle East to Malév's destinations in Western Europe. We believe that such an effect is probably (a) confined to smaller origin points with otherwise limited service, such as Odessa or Beirut; and (b) relatively small in magnitude, as most airports in reasonably large urban areas currently feature services to multiple major hubs, implying that removal of BUD from the picture would probably not significantly decrease the extent of competition. However, destinations in the Balkans, which lost services to Budapest following the bankruptcy event, could have suffered some appreciable loss in the level of one-stop competition. Austrian Airlines has traditionally held a dominant position on this market, with Malév potentially providing a viable competing network. Lack of suitable data does not, unfortunately, allow us to further expand on this point.

Loss of the hub position by Budapest airport could have other implications for business travelers, which we will unfortunately be unable to quantify within this study's framework. Bel and Fageda (2008) suggest a link between the number of destinations available from a local airport and the number of corporate headquarters in the city. Thus, hub operator's bankruptcy could have diminished the appeal of Budapest for business. Also, lack of flexible refundable ticket options and diminished opportunities to participate in the airlines' loyalty programs could present an additional inconvenience for business travelers.

III. Data

Our analysis will be based predominantly on the information about summer schedules at Budapest airport. Specifically, we will use the data on frequency and seat capacity for scheduled airline services from Budapest Airport⁶, included into summer schedules for 2011 and 2012. Both schedules cover the period from April until end of October of the respective year. The data were aggregated to different levels. First, to assess the extent of LCC versus network carriers' expansion at BUD after Malév's bankruptcy, we will look at the airline-destination level data. Next, data at the airport-market and city-pair market levels will be examined to understand the determinants of changes in the service levels after the bankruptcy event; as well as to assess patterns in airlines' entry and exit strategies. Differentiating between the notions of airport- and city-pair markets is important in light of point-to-point carriers' use of smaller secondary airports.

The schedule data is supplemented with the information on distances between the airports, the population and the income per capita at the destination. For the distance (in km) we used Malév Horizont Magazin (2010, September) and the website www.aircalculator.com. We retrieved latest larger urban zone population data from Eurostat⁷ and OECD as well. Similarly, the income

⁶ We would like to thank Patrick Bohl, Head of Airline Development and Strategy at BUD airport for kindly providing us the latest schedule data.

⁷Source: <http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcod=e=ts00080> (accessed on October 31, 2012)

per capita data come from OECD⁸. For destinations outside of the EU/OECD countries, we have used various data sources (mostly national statistical agencies) to obtain latest available figures for population and income per capita.

We have decided to group the following airports together to identify city-pair markets. In addition to physical proximity of the airports, in devising these groupings we considered the LCCs efforts to market the said airports as alternative gateways to the respective major metropolitan areas.

- London Heathrow, London Gatwick, London City, London Luton, and London Stansted
- Paris Charles de Gaulle, Paris Orly, and Paris Beauvais
- Charleroi and Brussels
- Helsinki, Turku, and Tampere
- Niederrhein (Weeze), Düsseldorf, Cologne-Bonn, and Dortmund
- Karlsruhe and Stuttgart
- Memmingen and Munich
- Frankfurt Hahn and Frankfurt Main
- Lübeck and Hamburg
- Berlin Schoenefeld and Berlin Tegel
- Rome Ciampino and Rome Fiumicino
- Bologna and Florence
- Venice Treviso and Venice Marco Polo
- Eindhoven and Amsterdam
- Rygge and Oslo
- Warsaw Modlin and Warsaw Chopin
- Gothenburg City and Gothenburg International
- Stockholm Arlanda and Stockholm Skavsta

There are admittedly several controversial issues in our definition of city-pairs. For example, Ryanair markets Weeze airport as an alternative to Amsterdam, despite the fact that the airport itself is over 150 km away from the city and in a different country, and the driving time between Weeze and Amsterdam is close to two hours. Also, we grouped Tampere, Turku, and Helsinki together, even though the airports are located at considerable distances from each other. The data analysis results however are not sensitive to regrouping of the city-pair markets taking the above considerations into account.

We will start with crude comparison of summer schedules across the two years. In 2011, the schedule includes 60,737 flights to 92 airports (corresponding to 79 city-markets, as defined above). The summer schedule of 2012 includes 46,721 flights to 94 airports (72 cities). This means that following Malév's bankruptcy, BUD lost about a quarter of scheduled flights. The decline in the number of seats is much less pronounced: the offered seat capacity went down from 7.5 million to about 6.9 million – about 8 percent decline. Decline in passenger numbers, reported by BUD on its web-site over the same time period is even less pronounced – around 5 percent (the airport does not however differentiate between scheduled and charter passengers). We should also note that we cannot really attribute the entire decline to Malév bankruptcy, as we do not know what Malév's schedule would have looked like if it remained operational in 2012 – the carrier could have downsized due to, for instance, the economic crisis in Europe.

⁸ OECD data are at country level.

Of the destinations served by Malév, services to fourteen have not been renewed by any other airline. Those destinations include points in the Middle East (Beirut and Damascus⁹), on the Balkans (Tirana, Skopje, Belgrade, Pristina), and in Eastern Europe (St. Petersburg and Odessa). Additionally, American Airlines (Malév's partner in oneworld alliance) chose to discontinue its flights to New York, and Hainan Airlines stopped flying to Beijing, marking loss of all long-haul services out of BUD¹⁰. The only medium-haul flight out of Ferihegy in summer 2012 schedule was Qatar Airlines service to Doha.

Overall, 62 cities (as defined above) have maintained scheduled non-stop services out of Budapest airport in both summer schedules. Of those, only 26 were served with higher frequency in 2012 than in 2011. Yet, over half of the cities (35) gained offered seat capacity in 2012 as compared to 2011.

Malév bankruptcy was followed by expansion of both LCC and network airlines' presence at Budapest airport. The lion's share of added capacity came from Ryanair and Wizzair. The two carriers are responsible for over one third of all summer 2012 scheduled departures (holding about equal market shares in terms of flight frequency). Lufthansa has become airport's third largest airline in terms of flight frequency (with 13 percent market share)¹¹. If we add all the carriers owned by Lufthansa to the picture (Swiss, Austrian, Brussels, and German Wings), Lufthansa group will become the largest carrier at BUD, with over 23 percent market share by the number of flights. Apart from Lufthansa, Wizzair, and Ryanair, no other carrier achieved more than 5 percent market share in terms of flight frequency.

Table 1 provides the destination-level descriptive statistics for our data. We provide some of the key indicators at both airport-level and city-level, as defined above. The following facts stand out from Table 1. First, an average destination lost about 18 percent of flights following the hub operator's bankruptcy. The number drops to 11 percent if we exclude discontinued destinations, still representing a substantial decline in flight frequency. The decline in the number of seats offered is much less pronounced (it is very small when we exclude destinations which have been discontinued), reflecting the airport-wide numbers discussed above. It also appears that discontinued destinations included less populous metropolitan areas with lower per capita income than average in the sample.

Before we continue with the data analysis, it pays to note several interesting developments that occurred after the summer schedule of 2012 expired. First, Wizzair started flights to Tel Aviv and Kiev, effectively replacing Malév on two more routes (yet, neither destinations lost all the services following the bankruptcy event, as El Al and Aerosvit kept their respective flights to BUD at expanded frequency). The delay in launching of these services could be related to the fact that Wizzair had to hold negotiations with the respective governments, as required by the corresponding bilateral air service agreements. Second, in November of 2012 Ryanair announced its plan to shut down ten of the routes it opened post-bankruptcy, citing high charges at BUD. As of September 2013, the carrier has retained services to 21 destinations out of

⁹ We could argue that services to Damascus would have been discontinued regardless of Malév's fate, due to the civil war that broke out in Syria at around the same time.

¹⁰ Interestingly, Aerosvit's bankruptcy also led to disappearance of all long-haul services out of Kyiv Boryspil airport.

¹¹ In 2011, Malév was the largest carrier at the airport, followed by Lufthansa and Wizzair with approximately equal number of flights.

Budapest, implying that the actual downsizing ended up being much less significant than originally planned.

IV. Data Analysis

In this section, we will subject our data to straightforward regression analysis, aimed at answering the following questions. First, we will analyze determinants of destination-level changes in the number of flights and seats offered, to assess whether any regularities can be discerned. In particular, we would like to understand whether on average the point-to-point carriers offer lower frequency than Malév did prior to bankruptcy, and if so, to quantify this frequency reduction for an average route. Next, we will focus on determinants of new and discontinued services. Finally, entry decisions of the key point-to-point carriers (Ryanair and Wizzair) will be scrutinized.

The following control variables will be used in our data analysis:

- Non-stop distance to the destination
- Population of the respective metropolitan area
- Per capita income of the destination metropolitan area, in Euros. Where conversion from the local currency was necessary, we used average July 2012 exchange rates.
- Indicator variable for island destinations – this variable is sometimes used in the literature (e.g. Bilotkach et al., 2010).
- Indicator variables for destinations served by Malév in 2011; Ryanair and Wizzair in 2012.
- Total and Malév flights to the destination in Summer 2011 schedule. These variables will be used in regressions examining the airlines' entry and exit as additional measures of market size.

In all the specifications, we will use natural logarithms of continuous independent variables to both mitigate the potential heteroscedasticity problem and enable interpretation of our estimated coefficients as (quasi-)elasticities.

Results of our data analysis are presented in Tables 2 through 5. Table 2 presents the results of regressions evaluating determinants of changes in frequency. The dependent variable in those regressions is the difference between destination-level frequency of service in Summer 2012 and Summer 2011 schedules. In addition to performing the data analysis on the sample that includes all destinations (from both Summer 2011 and 2012 schedules), we have re-estimated our specifications excluding discontinued destinations and excluding new markets. We also performed the analysis at both airport-level and city-level data. In the end, therefore, Table 2 includes output of six specifications. The estimation technique is straightforward feasible generalized least squares, with conventional White heteroscedasticity consistent standard errors employed to tackle the problem of non-spherical disturbances. Table 3 essentially repeats the analysis in Table 2, with difference in the number of seats offered used as the dependent variable.

Tables 4 and 5 report results of analysis of determinants of new and discontinued services. The dependent variables take on value of either zero or one, which necessitate the use of binary probit maximum likelihood estimation technique. As before, we need to be concerned about potential heteroscedasticity in the data – Huber/White robust standard errors are therefore used in all specifications. Additionally, all the regressions in Tables 4 and 5 are estimated on the city-level rather than destination airport-level data. Table 4 reports results of determinants of

discontinued services (the dependent variable takes on the value of one for cities to which flights from BUD were scheduled in Summer of 2011, but not in 2012); new airport services; and any new services. The difference between the latter two categories is that new airport services only include flights to the airports that have not been served from BUD in the Summer of 2011. For instance, a new service into Amsterdam – an airport served in 2011 – would be classified as “any new service” but not as a “new airport service”. Table 5 analyzes determinants of new services by the two leading point-to-point low cost carriers. We separately present results of estimation for Ryanair’s new services¹²; Wizzair’s new services – here we have to distinguish between destinations served by this carrier in 2011, and those the airline entered in 2012; and new services by either of the two low-cost carriers.

Our estimation results reveal the following facts. Tables 2 and 3 demonstrate that distance and endpoint’s demographic characteristics are not robust predictors of changes in either frequency or offered seats capacity, with the exception that island destinations appear to be attracting more services, other things equal. The latter result may be related to the strong presence of Ryanair on the British market, coupled with substantial Hungarian diaspora living there. At the same time, we can clearly see that, other things equal, a replacement of Malév with either Ryanair or Wizzair leads to an overall decline in the frequency of service – an expected result. This result is especially clearly visible at the city-level. *Specifically, Ryanair appears to add half of the frequency withdrawn by Malév; the corresponding figure for Wizzair is one third.*

Regressions reported in Table 4 reveal the following facts. First, the level of per capita income comes out as a strong predictor of discontinued services, with the expected negative sign. Destinations that had more flights to BUD in 2011 are less likely to be lost; at the same time, other things equal, the number of Malév flights in the Summer 2011 schedule is directly related to the likelihood that a service to a destination will be lost. New services appear to be short-haul, and link Budapest with higher-income higher-population destinations, which have been generally previously under-served – no surprises here.

Investigation of the determinants of new services by the leading point-to-point carriers, reported in Table 5, reveals the following results. Both carriers are attracted to flights to high-income destinations. Interestingly, Ryanair’s new services are more likely to be short-haul; and Wizzair is attracted to the lower-population destinations. The latter result could be explained by the fact that Wizzair, having had an established presence at BUD prior to Malév bankruptcy, could have entered the higher-population destinations before the event. Table 5 also reveals what appears to be an interesting difference in the two point-to-point carriers’ entry strategies. Ryanair appears to be more likely to enter routes with fewer total flights before bankruptcy (note that the results reported in Table 5 are city-level, and therefore cannot be explained away by the use of secondary airports by Ryanair). On the other hand, Wizzair is more likely to enter markets with more significant Malév presence in 2011. That is, while Ryanair appears to be seeking shorter-haul routes to higher-income destinations, which have generally been under-served; Wizzair’s strategy appears geared towards replacing Malév’s services.

¹² Technically, Ryanair is not present in Budapest in Summer 2011, so all Ryanair’s services are classified as new.

V. Assessment of changes in consumer welfare

V.1. Theoretical underpinnings

In this section of our study, we will present and apply a simple methodology for assessing the impact of Malév bankruptcy on welfare of origin-and-destination travelers. At the basic level, our data analysis results point to the existence of a lower-price-lower-frequency trade-off after the event. On one hand, as we have discussed above, lower frequency of service increases schedule delay. On the other hand, low-cost carriers replacing the network airline might bring lower airfares. So, the net effect on the full price of travel (defined as the sum of airfare and the schedule delay) is ambiguous. Formally, the full price of travel can be expressed as $p + \frac{\gamma}{f}$; and the passenger's utility then is:

$$U = y - p - \frac{\gamma}{f}$$

where y is passenger's disposable income; f is frequency; and γ is a parameter representing the degree to which extra flight increases customer's utility. Then, as in Bilotkach et al. (2010) we can assume that passengers are differentiated by income in the conventional way: y is uniformly distributed on $[0,1]$ interval. Further, we suppose that passenger's outside alternative (staying home or using personal transportation) is valued at zero – then, only those passengers for whom utility is positive will travel (or, those passengers for whom $y \geq p + \frac{\gamma}{f}$). Considering our assumption on distribution of income, demand for travel is given by:

$$Q = \int_{p+\frac{\gamma}{f}}^1 dy = 1 - p - \frac{\gamma}{f}$$

Then we can compute consumer surplus (or consumers' total utility across the entire income distribution) given that the price is p and frequency is f . Denoting $\alpha^* = p + \frac{\gamma}{f}$ we can write this consumer surplus as:

$$CS = \int_0^{\alpha^*} y dy + \int_{\alpha^*}^1 \left(y - p - \frac{\gamma}{f} \right) dy$$

The first component of the above expression is the utility obtained by the customers taking outside option (not flying), while the second is the total utility obtained by the traveling public. This expression can be more conveniently written as:

$$CS = \int_0^1 y dy - \int_{\alpha^*}^1 \left(p + \frac{\gamma}{f} \right) dy$$

Then the first of the two integrals is equal to 0.5 (note that this is just expectation of the normally distributed random variable on $[0,1]$ interval). The second integral is equal to:

$$\left(p + \frac{\gamma}{f} \right) \left(1 - p - \frac{\gamma}{f} \right)$$

The change in consumer surplus as we vary price and frequency of service can be assessed by taking the appropriate differential:

$$dCS = \frac{\partial CS}{\partial p} dp + \frac{\partial CS}{\partial f} df$$

The two partial derivatives are:

$$\frac{\partial CS}{\partial p} = -1 + 2p + 2\frac{\gamma}{f}$$

$$\frac{\partial CS}{\partial f} = -\frac{\gamma}{f^2} \left(-1 + 2p + 2\frac{\gamma}{f} \right)$$

Then, the differential we are looking for is equal to:

$$dCS = \left(1 - 2 \left(p + \frac{\gamma}{f} \right) \right) \left(\frac{\gamma}{f^2} df - dp \right)$$

Then, as long as $1 - 2 \left(p + \frac{\gamma}{f} \right)$ is positive¹³, the sign of dCS will be determined by the sign of $\frac{\gamma}{f^2} df - dp$. Note also that $\frac{\gamma}{f^2}$ is nothing but $\frac{\partial U}{\partial f}$ or the marginal effect of change in frequency on traveler's utility. Also observe that the above expression for the change in CS clearly reflects the lower-price-lower-frequency trade-off we were talking about above: a decrease in frequency ($df < 0$) decreases CS, while a decrease in price ($dp < 0$) increases it.

If we want to apply this model to our data and estimation results; we need to place plausible values on parameter γ , or at least on the marginal effect of change in frequency on utility. While Lijesen (2006) provides a thorough review of the relevant literature (in addition to constructing his own estimate of willingness to pay for higher frequency of service); making a connection between the available estimates of $\frac{\gamma}{f^2}$ and our specific case is complicated by the following factors. First, available estimates of the value of additional flight differ substantially across the studies. Second, the estimates are based on stated-preference rather than revealed-preference data. Third, most of the available estimates are based on the data from North American airline markets. Fourth, marginal utility of an extra flight will likely be different for leisure and business travelers and destinations.

Nevertheless, we will try to evaluate the minimum decrease in price required for the passengers to be better off in the end for a given decrease in frequency of service. Recall that the change in consumer surplus will be positive if:

$$\frac{\gamma}{f^2} df - dp > 0$$

Which can be rearranged as:

$$dp < \frac{\gamma}{f^2} df$$

The left-hand side of the above inequality is the change in price; the right-hand side is the marginal effect of change in frequency on consumer's utility. For instance, if $df = 0$, then any decrease in price increases consumer welfare, whereas any increase in price lowers it.

¹³ This condition will indeed hold for any reasonable market structure – see Bilotkach et al. (2010).

Changes in frequency of service can be obtained directly from the data. Combining these with the estimates of the marginal effects of change in frequency on consumer utility, we can get approximate declines in prices, which would compensate the travelers for lower frequency of service. Lijesen (2006) provides an overview of studies that estimated this very parameter (and performs one such study to add to this literature). Estimates reported by Lijesen vary quite widely. However, four studies (Lijesen, 2006; Morrison and Winston, 1985; Alamdari, 1989; Hess and Polak, 2004) offer reasonably similar estimates of these marginal effects¹⁴, which also vary with the frequency of service, consistently with the theoretical approach.

To approach the task at hand, we have taken the data points behind the marginal-effect-frequency relationships as reported in Lijesen (2006), Morrison and Winston (1985) and Alamdari (1989)¹⁵. We have averaged the corresponding marginal effects, and adjusted the resulting numbers for inflation (Lijesen's study was performed in 2005; according to Eurostat, cumulative inflation in the Eurozone between 2005 and 2012 constituted 18 percent). We have then proceeded to estimate the following relationship with simple OLS regression.

$$\frac{\partial U}{\partial f} = -16.22 + \frac{139.43}{f} + \varepsilon$$

Both coefficients are highly statistically significant, and the adjusted R-squared for this fit is 0.928, indicating that we have been able to approximate the data rather well. The estimated equation immediately suggests that we should not be concerned with any destinations with mean daily service frequency of more than 8.5 flights. The fitted values for the marginal effects for such destinations will be negative (the actual values are quite close to zero, implying marginal effect of under 2 euros).

Substantial variability of the marginal effects of frequency depending on the number of flights offered greatly complicated the problem of calculating the price decline required to make passengers as well off as before the bankruptcy event. As an example, suppose that before the bankruptcy five daily flights were available to a certain destination. Further suppose that this frequency decreased to two. The fitted marginal effect for five flights is EUR 11.70, implying the price decline of EUR 35.10 will be required to compensate the passengers for lower frequency of service. The fitted marginal effect for two daily flights is however EUR 53.50. In light of these complications, we will report two estimates of marginal effects. In addition to reporting the estimate based on the pre-bankruptcy frequency of service, or:

$$MU_f^{(1)} = \left[\frac{\partial U}{\partial f}(f_0) \right] (f_1 - f_0)$$

Where $\left[\frac{\partial U}{\partial f}(f_0) \right]$ is the marginal effect evaluated at pre-bankruptcy daily frequency, and $f_1 - f_0 = df$, we will report the marginal effect for the last daily flight removed from schedule following the bankruptcy event. Mathematically, we will evaluate:

$$MU_f^{(2)} = \left[\frac{\partial U}{\partial f}(f_1 + 1) \right]$$

¹⁴ In fact, Hess and Polak's estimates are consistently above those reported by the three other studies.

¹⁵ We are very grateful to Mark Lijesen for supplying us with the underlying numbers.

Coming back to the above example of five daily flights before frequency and two after, the above expression will imply that we will evaluate the marginal effect of the third flight (the fitted number based on the estimated relationship as reported above is EUR 30.25). Note two caveats for $MU_f^{(2)}$. First, $df = 1$ by construction. Second, it makes sense to compute $MU_f^{(2)}$ only for cases where $|f_1 - f_0| > 1$.

While reliable estimates of the network-full service carrier price differentials on European markets are not available, we can use evidence from the US market to gain some insights on this point. Most recently, Brueckner, Lee and Singer (forthcoming) demonstrated that an entry of a low cost carrier on the same route reduces average airfares by about 33 percent (20 percent if the low cost entrant serves an alternative airport in the same metropolitan area). Suppose, consistently with this, that Ryanair and Wizzair serve former Malév's routes via alternative smaller airports, implying a 20 percent drop in fare post-bankruptcy on the markets where the low-cost carriers replace Malév's services.

Additionally, we have obtained access to fare quotes by network and low-cost carriers, collected on a number of European routes in 2005¹⁶. We have identified several London-originating routes, served by both network and low-cost carriers, to compare the corresponding average fare quotes. Table 6 compares average one-way fare quotes for LCC and network carriers on London-Dublin, London-Riga, London-Budapest, and London-Warsaw routes, collected 14, 21, and 28 days before the flight departure date. Each number is the average for hundreds to several thousand observations¹⁷. The values are in pound sterling¹⁸. We should note that fare quotes are given net of taxes and fees; and differences across the network and LCC carriers' pricing strategies and products make direct comparison of quotes problematic. In particular, the following points should be noted. First, network carriers are known to price discriminate between one-way and roundtrip passengers, so that network carriers' lowest one-way fares require purchasing a return ticket; whereas low-cost carriers do not typically make such a distinction. Second, LCCs are more likely to charge a booking fee. Third, low-cost carriers do not include add-on services, such as checked luggage, seat reservations, and in-flight drinks/meals into the ticket price. Given these facts, we believe that the figures presented in Table 6 somewhat overestimate the actual price differentials between network and low-cost carriers.

The average LCC-network price differential found in Table 6 is GBP 34.50 (around EUR 50 at 2005 exchange rate). In addition to the fact that this differential might be inflated by the above considerations, we should note that the euro has appreciated relative to pound from 2005 to 2012, so that GBP 34.50 price differential would correspond to about EUR 43 in 2012. We suppose (quite arbitrarily, to be honest) that the above considerations probably shrink the price differential by about a quarter, to EUR 32.25. We will be using this number as a guesstimate of the likely one-way price decrease resulting from a low-cost carrier serving the route previously served by Malév.

¹⁶ The data were provided by Claudio Piga, who collected these quotes. We are very grateful to Claudio for giving us this information.

¹⁷ For example, average quote for network carriers on London-Budapest route 14 days before departure is based on 2,095 observations; whereas the corresponding number for LCC is averaged across 669 observations, including quotes for flights from both Luton and Gatwick.

¹⁸ Annual average exchange rate in 2005 was about EUR 1.45 per 1 pound.

V.2. Application to data

We will apply our estimates of price drops required to compensate for lower frequency to data in the following ways. First, consider our estimation results reported in Table 2. We suggest that, looking at the city-level data and keeping other things constant; Ryanair replaces Malév's services with half as many flights as the now bankrupt carrier offered before going bust. The corresponding figure for Wizzair is one-third. We can then compute the one-way price drops required to compensate the passengers for higher schedule delay, assuming Malév was the only airline offering non-stop service before the bankruptcy; and that only entry by either Ryanair or Wizzair occurred. Figure 1 presents these estimates. We computed values for both $MU_f^{(1)}$ and $MU_f^{(2)}$. Figure 1 essentially suggests that, unless Malév was offering at least four flights pre-bankruptcy, replacement of this carrier by Ryanair would probably not lead to an improvement in consumer welfare. Based on our estimates, on an average route where Malév offered four flights per day, Ryanair would enter with two daily flights. The price drop for one-way ticket, required to adequately compensate the passengers for this reduction in frequency is EUR 30.25 or EUR 37.27, depending on the measure used. We have also indicated above that we would use EUR 32.25 as a likely actual price drop following the replacement of Malév by an LCC. Given that Wizzair enters the former Malév routes with even lower frequency: we can suspect that on average there is a potential for the passengers to be getting a worse deal with LCCs than with Malév¹⁹.

Second, we will apply our analysis to actual numbers from our data. Table 7 presents estimates of the lowest fare decrease, required to compensate passengers for lower frequency, for 31 metropolitan areas, which lost some but not all flight frequencies to BUD in Summer 2012 as compared to Summer 2011. To be included into this list, the metropolitan area had to meet the following requirements:

- Be served by Malév in the Summer of 2011;
- Retain some services from Budapest in the Summer of 2012;
- Exhibit average daily flight frequency of at least 0.5 in the Summer of 2011 – one flight every other day²⁰;
- Show decline in daily frequency in the Summer of 2012 as compared to Summer of 2011.

Of the 31 cities included into Table 7, eighteen have experienced entry of low-cost carriers (Ryanair and/or Wizzair) following Malév bankruptcy. This means that passengers traveling to the remaining fourteen cities can expect lower frequency of services accompanied by the same or maybe even higher fares, as departure of Malév was not accompanied by new low-cost carrier entry. On some routes (Burgas, Targu Mures) departure of Malév meant that Wizzair remained as the only carrier providing non-stop services.

Focusing now on those airports where LCC entry did occur after Malév went bankrupt, we can say the following. The range of the estimates of the compensating price differential – a price drop required to fully compensate the passengers for lower frequency of service – is from zero²¹ (London) to over EUR 100 (Varna). Presuming that entry of a new LCC (for London this would

¹⁹ Mean pre-bankruptcy daily frequency at the city-pair markets where Malév was present is around 2.5 flights.

²⁰ This restriction weeds out some leisure destinations – it is not likely that marginal effects we are using here will apply to them, given the likely passenger mix on those flights.

²¹ The value in Table 7 is set to zero where the estimated corresponding marginal effect is negative.

be Ryanair service to Stansted) would result in a drop in average fare to that destination, we can surmise that passengers flying to London are probably better off after Malév bankruptcy, given an overall small decrease in frequency of service. At the other extreme, passengers traveling to Varna would probably not be compensated adequately for the decreased frequency of service, and can be expected to be worse off as a result of Malév bankruptcy. Using the above selected (admittedly somewhat arbitrary) cut-off compensating price differential, we can suspect that passengers traveling to seven destinations (Milan, Varna, Sofia, Thessaloniki, Larnaca, Goteborg, and Venice) could potentially be worse off after the bankruptcy event, despite entry of low-cost carriers on those routes to replace services that have been provided by Malév, with Stockholm representing a borderline case. Passengers traveling to the remaining ten destinations where total frequency of service decreased and Malév was replaced by an LCC are likely to be better off.

We need to add a number of caveats to the guesstimates we reported above. Most importantly, we are using estimates of both marginal effects of frequency reduction on consumer utility, which are not based on the data that come from the markets in question. Further, our estimates of likely network-LCC price differentials are very rough. Also, the marginal effects are very likely to vary with passengers' income and trip purpose, as well as with the travel time. Last but not least, we only give brief credit to the fact that low-cost carriers are likely to enter a metropolitan area with a service to smaller airports, without looking deeper into the increase in travel time this creates for some if not most passengers. Nevertheless, our analysis gives us a first approximation at quantifying the lower-price-lower-frequency trade-off, thus giving us a way to address the question of whether consumers are likely to be better or worse off following Malév bankruptcy. We are also providing a methodological approach, which could be used to assess actual or potential future instances of de-hubbing following bankruptcy of a legacy network carrier.

Overall, we can say the following about the likely consumer welfare effects of Malév bankruptcy event. Excluding new and discontinued destinations, twenty cities saw their post-bankruptcy frequency of service to BUD increase, whereas flights to 31 cities have become less frequent. In 11 out of 31 cases, passengers are likely to be more than adequately compensated by lower fares for the observed decline in service frequency. Services to 20 destinations likely adversely affected by the bankruptcy event comprise about 15 percent of post-bankruptcy seats offered on flights out of BUD. This number is likely to be reduced further following Wizzair's entry into Kiev and Tel Aviv markets. We can thus conclude that while Malév's bankruptcy could have hurt passengers on some of the routes out of Budapest; the negative effects have likely been limited.

VI. Concluding Comments

This paper examines the events that followed the bankruptcy of Malév Hungarian Airlines in February of 2012. We address the question of the likely effects of this event on consumer welfare. Two questions are of particular interest to us. First, we examine the determinants of changes in the level of service for different destinations, as well as the factors that influence the entry strategies of point-to-point carriers following the demise of a network airline. Second, we identify and evaluate a trade-off, stipulated by the point-to-point carriers' business model. Specifically, while point-to-point carriers in the market in question tend to offer lower fares as compared to network airlines; they also offer lower frequency of service. As a result, the consumer welfare implications of replacement of a network carrier's services with flights by point-to-point airline are ambiguous.

With respect to the first question, analysis of the pre- and post-bankruptcy schedules of Budapest airport reveals the following. There has indeed been a sizeable decrease in the number of air transport movements at BUD, which was accompanied by a less significant decline in the passenger volumes. The point-to-point carriers entered with substantially lower frequency of services as compared to what was offered by Malév. Ryanair and Wizzair were seeking high-income destinations, which have been underserved in 2011. Wizzair's strategy appears to be more geared towards replacement of Malév's services, as compared to Ryanair's.

To evaluate the price-frequency trade-off, we have used previously reported valuations of frequency of service by passengers, and applied them to our data to estimate the minimum price reductions, which would be required to compensate the passengers for lower frequency of service. Our exercise identified seven destinations (airports that are mostly located in smaller metropolitan areas, except for Milan), where entry of low-cost point-to-point carriers could have conceivably left passengers worse off; as the price reductions that would be required to compensate the passengers for lower frequency of service are higher than the actual reductions we could expect from the LCCs. At the same time, eleven destinations have been identified, where entry of the point-to-point carrier most likely makes passengers better off, despite lower frequency of service.

Overall, while our analysis did identify some destinations, travel to which from BUD has most likely been adversely affected by the hub operator's bankruptcy; we can also say that on a number of routes the situation has improved following the entry of point-to-point carriers. We should however also note that our analysis presented a snapshot of what happened during the summer after the bankruptcy event. Several developments since then (entry of Wizzair into new routes; Ryanair's threat to curtail its presence at BUD; introducing the new national carrier 'Sólyom Airways' in August 2013) could have rendered some of our conclusions obsolete. However, our study does provide both some lessons for the airports planning for the de-hubbing contingency, and the methodology for addressing the price-frequency trade-off.

A number of important issues remained outside of the scope of our analysis. In addition to points mentioned elsewhere in the paper, we believe that future research efforts should focus on the issues of consumer heterogeneity and airport strategies. The former refers to the need to evaluate the effect of de-hubbing events on business and leisure travelers. The latter concerns with the strategies an airport can employ (mostly dealing with changing the level and structure of its charges) to mitigate the impact of adverse developments, such as losing the largest airline customer, and a quarter of air traffic movements with it. These issues are left out of our analysis due to lack of the appropriate data.

References:

- Alamdari, F.E. (1989) "Airline Deregulation: an Analysis under Different Regulatory and Operating Environments," research thesis, Cranfield Institute of Technology, UK
- Alderighi, M. and A. Gaggero (2013) "Air accessibility and the export of Italian manufacture in Europe: Evidence at regional level", working paper
- Bel, G., and X. Fageda (2008) "Getting There Fast: Globalization, Intercontinental Flights and Location of Headquarters", *Journal of Economic Geography*, 8, 471-495

- Berry, S. (1992) "Estimation of a Model of Entry in the Airline Industry", *Econometrica*, 60, 889-917
- Bilotkach, V., Clougherty, J., J. Mueller, and A. Zhang (2012) "Regulation, Privatization, and Airport Charges: Panel Data Evidence from European Airports", *Journal of Regulatory Economics*, 42, 73-94.
- Bilotkach, V., X. Fageda, and R. Flores-Fillol (2010) "Scheduled Service versus Personal Transportation: The Role of Distance", *Regional Science and Urban Economics*, 40, 60-72
- Boguslaski, R., H. Ito, and D. Lee (2004) "Entry Patterns in the Southwest Airlines Route System" *Review of Industrial Organization*, 25, 317-350
- Brueckner, J. K., D. Lee, and E. Singer (forthcoming) "Airline Competition and Domestic U.S. Airfares: A Comprehensive Reappraisal," *Economics of Transportation*, forthcoming.
- Ciliberto, F., and J.W. Williams (2010) "Limited Access to Airport Facilities and Market Power in the Airline Industry" *Journal of Law and Economics*, 53, 467-495
- Dunn, A. (2008) "Do low-quality products affect high-quality entry? Multi-product firms and nonstop entry in airline markets" *International Journal of Industrial Organization*, 26, 1074-1089
- Goolsbee, A. and C. Syverson (2008) "How do Incumbents Respond to the Threat of Entry? Evidence from the Major Airlines" *The Quarterly Journal of Economics*, 123, 1611-1633
- Hess, S. and J.W. Polak (2004) "Mixed Logit Modeling of Airport Choice in Multi-Airport Regions," *Journal of Air Transport Management*, 11, 59-68
- Joskow, A., G. Werden, and R. Johnson (1994) "Entry, Exit, and Performance in Airline Markets" *International Journal of Industrial Organization*, 12, 457-471
- Lijesen, M.G. (2006) "A mixed logit based valuation of frequency in civil aviation from SP-data", *Transportation Research Part E*, 42, 82-94
- Lin, J.-S., M. Dresner, and R. Windle (2002) "Determinants of Price Reactions to Entry in the U.S. Airline Industry" *Transportation Journal*, 41, 5-22
- Malév Horizont Magazin (2010, September)
- Morrison, S., and C. Winston (1985) "An econometric analysis of the demand for intercity passenger transportation," *Research in Transportation Economics*, 2, 213-237
- Mueller, K., V. Bilotkach, and K. Hueschelrath, (2012) "The Construction of a Low Cost Airline Network: Facing Competition and Exploring New Markets", *Managerial and Decision Economics*, 33, 485-499
- Oliveira, A. V. (2008) "An empirical model of low-cost carrier entry", *Transportation Research Part A: Policy & Practice*, 42, 673-695
- Redondi, R., P. Malighetti, and S. Paelari (2012) "De-hubbing of airports and their recovery patterns", *Journal of Air Transport Management*, 18, 1-4

Reiss, P. C. and P. T. Spiller (1989) "Competition and Entry in Small Airline Markets" *Journal of Law and Economics*, 32, S179-S202

Sinclair, R. A. (1995) "An empirical model of entry and exit in airline markets" *Review of Industrial Organization*, 10, 541-557

Table 1 Descriptive Statistics

Variable		All destinations	Excluding discontinued destinations	Excluding new destinations
Change in frequency	APM level	-123 (362)	-79 (358)	-202 (346)
	CPM level	-157 (309)	-108 (301)	-218 (314)
Change in seats offered	APM level	-5,733 (51,383)	-545 (52,361)	-16,337 (48,400)
	CPM level	-7,343 (43,028)	-1,233 (43,580)	-16,860 (44,136)
Distance, km		1,257 (984)	1,286 (1,014)	1,273 (1,056)
Population		2,744,000 (3,645,560)	2,961,193 (3,815,982)	2,768,621 (3,749,867)
Per capita income, annual, EUR		17,716 (8,807)	19,295 (8,037)	17,044 (9,495)
Total flights in 2011 summer schedule	APM level	660 (603)	700 (642)	660 (603)
	CPM level	769 (799)	837 (861)	646 (660)
Malév flights in 2011 summer schedule		560 (305)	606 (325)	560 (305)

Notes:

1. Reported numbers are un-weighted averages. Standard deviations are in parentheses
2. APM stands for airport-pair market, CPM for city-pair market. See Data description for definition of airport groupings used
3. Total flights in 2011 schedule averaged across destinations with non-zero flights in 2011 summer schedule
4. Malév flights in 2011 schedule averaged across destinations with non-zero Malév flights in the corresponding schedule

Table 2 Determinants of Changes in Frequency

	Airport-Pair Market Level			City-Pair Market Level		
	All destinations	Excluding discontinued destinations	Excluding new destinations	All destinations	Excluding discontinued destinations	Excluding new destinations
Constant	-364.11 (544.44)	-187.74 (735.29)	-215.49 (596.13)	-573.06 (662.03)	-221.73 (844.97)	-321.92 (735.73)
Log(Distance)	27.817 (44.124)	0.7592 (48.010)	65.675 (57.572)	48.982 (50.558)	26.446 (56.264)	83.648 (66.195)
Log(Population)	2.537 (18.76)	0.2783 (20.428)	-21.032 (23.173)	-7.025 (18.350)	-14.355 (20.016)	-18.023 (28.426)
Log(Per capita income)	1.756 (38.128)	6.2817 (51.973)	-8.6008 (39.654)	24.724 (47.322)	15.164 (60.754)	-14.603 (47.824)
Island destination	141.14* (75.979)	151.93* (77.511)	117.73 (81.381)	145.47** (57.819)	144.49** (58.826)	182.49** (85.568)
Malév destination	-318.72** (53.273)	-323.80** (55.858)	-309.41** (57.917)	-291.56** (59.651)	-285.90** (64.456)	-308.68** (75.284)
Ryanair destination	326.17** (55.098)	326.13** (55.213)	315.53** (86.951)	148.02** (62.810)	161.86** (64.203)	165.79 (103.48)
Wizzair destination	131.88** (45.988)	130.99*** (50.913)	146.48** (45.868)	108.90** (53.893)	104.81* (62.368)	139.93** (55.396)
Adjusted R-squared	0.5527	0.5171	0.4852	0.3552	0.2688	0.3433
Observations	114	100	92	89	75	67

Notes:

1. Dependent variable is difference in scheduled frequency between Summer 2012 and Summer 2011 schedules
2. White heteroscedasticity consistent standard errors in parentheses
3. Malév destinations classified according to 2011 schedule; Ryanair and Wizzair destinations determined from Summer 2012 schedule
4. Island destination variable includes destinations on Mediterranean islands, UK, and Ireland
5. Significance: * - 10%; ** - 5%

Table 3 Determinants of Changes in Seats

	Airport-Pair Market Level			City-Pair Market Level		
	All destinations	Excluding discontinued destinations	Excluding new destinations	All destinations	Excluding discontinued destinations	Excluding new destinations
Constant	62,587 (79,377)	89,739 (108,608)	105,658 (85,076)	28,520 (96,951)	75,165 (122,334)	83,827 (108,806)
Log(Distance)	-11,026 (7,469.5)	-13,625 (8,700.1)	-9,159.3 (9,283.1)	-9,951.3 (7,807.2)	-11,926 (9,133.3)	-7,363.2 (10,424)
Log(Population)	1,662.9 (2,862.7)	1,390.5 (3,147.8)	-1,904.2 (3,379.0)	1,494.3 (2,435.4)	592.86 (2,584.4)	-948.83 (3,971.8)
Log(Per capita income)	-2,285.5 (4,553.6)	-2,817.2 (5,954.0)	-2,956.5 (4,814.1)	813.55 (6,163.3)	-1,312.2 (7,373.5)	-3,418.8 (6,686.5)
Island destination	21,208* (12,729)	22,464* (13,080)	15,884 (13,091)	22,662** (9,107.0)	22,374** (9,455.9)	22,740* (12,613)
Malév destination	-35,158** (6,777.6)	-35,805** (7,506.5)	-34,763** (7,374.3)	-29,422** (7,588.1)	-28,542** (8,651.0)	-33,677** (9,950.4)
Ryanair destination	57,243** (9,047.4)	57,439** (9,146.6)	60,947** (14,889)	38,462** (8,867.7)	40,643** (9,138.2)	45,161** (15,783)
Wizzair destination	17,049** (7,053.8)	16,844** (7,940.9)	16,095** (5,765.9)	15,686** (7,178.5)	15,215* (8,474.8)	15,450** (7,623.2)
Adjusted R-squared	0.5140	0.4850	0.4412	0.3561	0.2966	0.2818
Observations	114	100	92	89	75	67

Notes:

1. Dependent variable is difference in scheduled seats between Summer 2012 and Summer 2011 schedules
2. White heteroscedasticity consistent standard errors in parentheses
3. Malév destinations classified according to 2011 schedule; Ryanair and Wizzair destinations determined from Summer 2012 schedule
4. Island destination variable includes destinations on Mediterranean islands, UK, and Ireland
5. Significance: * - 10%; ** - 5%

Table 4 Probit Regressions, City-Pair Market Level

	Discontinued service	New airport service	Any new service
Constant	10.838** (5.3567)	-17.333** (4.8756)	-7.7907** (3.3124)
Log(Distance)	0.5906 (0.4394)	-1.1288** (0.4463)	-0.9207** (0.3446)
Log(Population)	-0.1442 (0.2009)	0.6009** (0.2174)	0.2563** (0.1459)
Log(Income)	-1.6332** (0.4562)	1.8900** (0.5135)	1.2488** (0.3446)
Log(Total lights in Summer 2011)	-3.6996** (1.3125)	-0.5437** (0.1557)	-0.5295** (0.1368)
Log(Malév flights in Summer 2011)	4.0501** (1.2617)	0.1364* (0.0789)	0.2597** (0.0822)
Island destination	NA	0.4680 (0.5238)	0.9352** (0.4668)
McFadden R-squared	0.6762	0.4041	0.3302

Notes:

1. Dependent variables: indicator variables for discontinued services, services to cities which were not served in 2011; and new services (either to new airports or to the previously served airports by the new airlines), respectively
2. Estimation technique: binary probit, maximum likelihood estimation
3. All observations are city-pair market level. Number of observations – 89
4. Huber/White robust standard errors in parentheses
5. Island destination variable includes destinations on Mediterranean islands, UK, and Ireland
6. Significance: * - 10%; ** - 5%

Table 5 Probit Regressions, LCC Entry, City-Pair Market Level

	Ryanair, New Services	Wizzair, New Services	Ryanair or Wlzzair, New Services
Constant	-11.979** (3.6704)	-3.1767 (3.0804)	-5.7014* (3.0218)
Log(Distance)	-0.5390* (0.3117)	-0.0405 (0.3932)	-0.4131 (0.2818)
Log(Population)	0.1955 (0.1561)	-0.2636* (0.1428)	-0.0522 (0.1349)
Log(Income)	1.3353** (0.3542)	0.5154** (0.2559)	0.9438** (0.2822)
Log(Total lights in Summer 2011)	-0.2149** (0.0981)	-0.0120 (0.0921)	-0.2040** (0.0951)
Log(Malév flights in Summer 2011)	0.0962 (0.0726)	0.2319** (0.1049)	0.1603** (0.0735)
Island destination	-0.0022 (0.4666)	0.9098* (0.4880)	0.6697 (0.4291)
McFadden R-squared	0.1912	0.2250	0.1717

Notes:

1. Dependent variables: indicator variables for respective LCC services, which are included into Summer 2012 schedule, but were absent from Summer 2011 timetable
2. Estimation technique: binary probit, maximum likelihood estimation
3. All observations are city-pair market level. Number of observations – 89
4. Huber/White robust standard errors in parentheses
5. Island destination variable includes destinations on Mediterranean islands, UK, and Ireland
6. Significance: * - 10%; ** - 5%

Table 6 Network–LCC price quote differences

		Days before Departure		
		14	21	28
London-Dublin	Network	68.88	58.99	52.66
	LCC	27.65	22.53	20.02
	Difference	41.24	36.46	32.63
London-Budapest	Network	93.78	82.99	74.19
	LCC	48.87	45.34	47.21
	Difference	44.91	37.65	26.98
London-Riga	Network	117.72	107.58	105.34
	LCC	61.70	57.08	54.59
	Difference	56.02	50.50	50.74
London-Warsaw	Network	94.37	87.19	78.41
	LCC	82.75	72.75	67.58
	Difference	11.62	14.43	10.83

These numbers represent average one-way fare quotes (in GBP) collected on given routes for network and LCC carriers in 2005. Computed by the authors based on the data provided by Claudio Piga. More detailed information is available from the authors upon request.

Figure 1 Price Drops Required to Compensate for Lower Frequency, Based on Regression Estimates

Note: Based on results reported in Table 2 at the city level, we suppose that Ryanair enters with half of Malév's frequency before bankruptcy, and Wizzair offers a third as many flights as Malév offered.

Table 7 Estimated price declines required to compensate for lower frequency

Destination (City level)	Daily frequency, Summer 2011	Decline in daily frequency, Summer 2012 versus 2011	One-way price decrease producing zero net consumer welfare effect, EUR	
			$MU_f^{(1)}$	$MU_f^{(2)}$
Markets with LCC entry post-bankruptcy				
Varna	1.52	1.39	105.72	108.21
Larnaca	1.37	1.05	89.57	89.15
Sofia	1.78	1.28	79.92	77.16
Venice	1.28	0.77	71.48	--
Thessaloniki	1.93	1.25	70.10	66.80
Goteborg	2.05	1.03	53.38	52.83
Milan	2.84	1.71	56.09	49.11
Stockholm	3.34	1.13	28.78	27.17
Stuttgart	2.91	0.63	19.98	--
Madrid	2.55	0.41	15.56	--
Helsinki	3.61	0.25	5.71	--
Bucharest	4.71	1.25	16.82	15.10
Warsaw	4.70	0.48	6.50	--
Frankfurt	8.48	2.13	0.46	2.75
Paris	7.60	1.74	3.71	4.11
Dusseldorf	6.49	0.56	2.94	--
Amsterdam	7.39	0.39	1.02	--
London	11.66	0.15	0.00	--
Markets without LCC entry post-bankruptcy				
Basel	0.50	0.37	98.15	--
Burgas	0.52	0.28	72.51	--
Targu Mures	1.49	0.98	75.89	--
Athens	2.23	1.55	71.81	66.80
Zagreb	2.61	1.67	62.03	55.56
Geneva	2.16	1.14	55.12	52.83
Copenhagen	2.84	1.92	63.28	56.59
Tel Aviv	3.13	1.96	55.45	47.96
Kiev	2.55	0.68	26.20	--
Moscow	3.24	0.87	23.23	--
Istanbul	2.69	0.39	13.83	--
Zurich	4.65	1.09	14.98	14.35
Prague	5.54	1.89	16.97	13.80

The price differentials correspond to the smallest change in one-way fare, which would compensate the customers for lower frequency of service on the route. Where the estimated marginal effect turned out negative, we use the value of zero in the Table. $MU_f^{(2)}$ was not calculated where change in daily frequency was less than 1. Destinations in **bold** correspond to routes with LCC entry, where passengers are likely to be worse off following the event. Destinations in *italics* are those where LCC entry likely increased consumer welfare.