AIR NAVIGATION SERVICE CHARGES IN EUROPE

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Abstract

This paper analyzes benefits and pitfalls of the current European charging scheme from the perspective of Air Navigation Service Providers, airspace users and passengers following the introduction of the European Commission Regulation 1794/2006 laying down a common charging scheme for air navigation services.

Introduction

Air navigation service charges play a major role in shaping Air Transportation in Europe from a financial and economic point of view. Indeed, air navigation service charges are by far the main source of revenues for any European Air Navigation Service Provider (ANSP) [1]. On the airspace users' side, the Association of European Airlines (AEA) claims that air navigation service charges account for 9% of direct operating costs of its members in 2005 [2]. Finally, the European Commission estimates that '*yearly turnover of the air navigation service industry amounts to about € 7 billion: for every euro spent on the airline ticket today, some 6% is devoted to air navigation services*' [3]. Despite the limited attention received in the literature so far, the above figures prove the need to clearly understand how air navigation service charges affect the different stakeholders of the European air transportation system.

To harmonize strategies and preserve safety in the field of air traffic management (ATM) at the European level, the EUROCONTROL Agency has been set up in the early sixties. Its primary objective is the development of a seamless pan-European ATM system. As of January 2007, it numbers 37 member states. Any of them is obliged to comply with the Multilateral Agreement relating to Route Charges, which is '*an international agreement signed in 1981 by which Contracting States decided to adopt a common policy, to create a joint system for the calculation, billing and recovery of their route charges and to use for this purpose the services of EUROCONTROL'*. To this aim, the EUROCONTROL Central Route Charges Office (CRCO) bills and collects en route charges on behalf of EUROCONTROL Member States.

On 6 December 2006, the European Commission has adopted Regulation 1794/2006 laying down a common charging scheme for air navigation services. It applies from 1 January 2007 and is fully consistent with the EUROCONTROL Multilateral Agreement. Nevertheless, this new regulation is a major step in the implementation of the Single European Sky because it enhances the enforcement of the existing system and harmonises air navigation service charges in the European airspace. It also brings additional features: first, terminal charges are fully included in the scheme. In addition, charging zones are defined to promote integrated management of the airspace in regional airspace blocks. In the European Commission's aims this new regulation '*will ensure that the charges levied are fair, transparent and reflect the real cost of services, will encourage the safe and effective provision of air navigation services, and will reinforce consultation mechanisms of airspace users*' [3]. Unless otherwise stated, in the remainder of the paper we refer to it simply as 'the Regulation'.

In the following, we comment the Regulation and highlight the impact that such rules may have on ANSPs, airspace users and passengers. Since most features of the Regulation were already included in the Multilateral Agreement, some of our findings can be easily based on studies performed in the last years. For sake of simplicity, we assume that all the countries we mention are both subject to the Multilateral Agreement and the Regulation[1].

Air Navigation Service Charges

Any user of air navigation services performing a flight in one or more national airspaces is requested to pay air navigation charges for such flight. Exemptions may exist, notably Visual Flight Rules (VFR), military, training, humanitarian, and other flights (see Article 9 of Regulation for more details). Air navigation charges are composed of en route and terminal charges. They are levied to finance costs for providing en route and terminal services, respectively. They are due only for flights actually performed. Any planned flight, but eventually cancelled, cannot be charged. The Regulation introduces the concept of *charging zone* that is defined as a volume of airspace for which a

[1] As of January 2007, 25 countries are simultaneously members of both EUROCONTROL and the European Union. Instead, 39 countries belong to either the European Union or EUROCONTROL.

single cost base and a single unit rate are established.

En Route Charges

In accordance with Article 10 and Annex IV of the Regulation, the en route charge r for a specific flight in a specific en route charging zone is equal to $r = d \times p_r \times u_r$ where d is the distance factor, p_r is the en route weight factor of the aircraft and u_r is the en route unit rate of the en route charging zone. The product of the distance and weight factors is referred to as en route service unit s_r, i.e., $s_r = d \times p_r$. These parameters are calculated as follows:

- d is the distance factor and is obtained by dividing by one hundred the number of kilometres flown in the great circle distance between entry and exit point of the en route charging zone, according to the latest known flight plan filed by the aircraft. The distance to be taken into account is to be reduced by twenty kilometres for each take-off and each landing on the territory of a Member State.
- $p_r = \sqrt{\frac{MTOW}{50}}$, i.e., the en route weight factor is equal to the square root of the quotient obtained by dividing by fifty the number of metric tons in the maximum certificated take-off weight (MTOW) of the aircraft.
- u_r is the en route charging zone unit rate and is calculated by dividing the forecast number of chargeable en route service units for the relevant year into the forecast costs for air navigation services. The balance resulting from under or over recovery of previous years is included in forecast costs.

Terminal Charges

In accordance with Article 11 and Annex V of the Regulation, the terminal charge t for a specific flight in a specific terminal charging zone is equal to $t = p_t \times u_t$, where p is the terminal weight factor of the aircraft and ut is the unit rate of the terminal charging zone. The weight factor is also referred to as terminal service unit s_t, i.e., $s_t = p_t$. The terminal weight factor is equal to $p_t = \left(\frac{MTOW}{50}\right)^{0.7}$, and the terminal charging zone unit rate u_t is calculated by dividing the forecast number of chargeable terminal service units for the relevant year into the forecast costs for air navigation services. The balance resulting from under or over recovery of previous years are included in forecast costs.

Unit rates are set for each charging zone on an annual basis and can be modified during the course of the year only if unexpected major changes in traffic or costs occur (Article 13 of the Regulation). A single charge per flight is collected (Article 14 of the Regulation), which is equal to the sum of the terminal and en route charges of the charging zones flown.

Analysis of en route unit rates

So far, charging zones overlap with national airspaces of each member state. Hence, each state publishes its own en route unit rate. Exceptions are Portugal and Spain which distinguish between continental (LP – Portugal Lisboa, LE – Spain Continental) and over the Atlantic Ocean airspaces (GC – Spain Canarias, AZ – Portugal Santa Maria). Table 1 shows en route unit rates from year 2000 to 2007 for 28 en route charging zones. In the Appendix, Table A presents the ICAO codes corresponding to each charging zone. Figure 1 presents for each charging zone the minimum, the maximum and the mean en route unit rates over the eight years under consideration sorted in increasing order of the mean unit rate.

ICAO CODE	2000	2001	2002	2003	2004	2005	2006	2007
EB	59,82	66,91	66,91	95,23	90,86	83,83	76,95	70,95
ED	60,71	68,03	68,03	92,51	89,54	71,49	63,30	67,37
LF	54,60	52,42	52,42	62,19	61,57	60,58	60,13	60,97
EG	84,32	82,70	85,35	84,08	82,77	81,18	81,47	81,70
EH	47,60	53,09	53,09	65,99	61,45	53,69	49,38	47,67
EI	20,84	19,67	19,67	28,60	32,11	31,09	28,16	24,95
LS	72,04	77,25	79,16	97,55	91,88	86,86	69,94	71,16
LP	38,07	40,46	40,46	52,29	51,03	49,02	49,21	48,22
LO	63,54	65,57	65,57	72,49	71,71	68,65	58,93	58,05
LE	44,65	49,20	49,20	71,59	71,57	71,95	72,64	76,64
GC	44,06	50,22	50,22	67,01	66,99	66,05	66,46	67,75
AZ	16,36	12,78	12,78	21,07	17,92	14,98	14,64	13,29
LG	30,53	37,07	37,07	44,30	38,26	36,84	41,82	44,18
LT	39,31	44,49	30,10	30,52	32,66	28,50	27,26	26,85
LM	34,25	43,73	40,69	36,60	28,70	31,67	33,72	34,80
LI	63,54	56,47	56,47	68,24	68,53	69,57	67,67	67,66
LC	23,52	19,61	19,56	31,48	33,60	34,60	33,64	35,50
LH	27,02	28,58	30,68	39,34	36,66	35,00	30,67	30,35
EN	49,34	53,50	54,51	72,52	62,94	60,50	55,42	63,54
EK	52,23	52,12	52,23	63,73	68,32	57,03	55,15	55,15
LJ	62,58	61,65	60,10	73,43	76,33	70,02	57,29	60,77
LR	40,03	42,52	42,52	47,83	41,38	40,97	39,63	39,55
LK	36,79	35,27	37,95	36,57	30,35	27,47	35,37	41,80
ES	44,90	53,13	48,96	59,36	65,17	51,40	42,02	47,51
LZ	56,51	58,31	58,96	59,14	55,65	40,71	39,79	40,71
LD	58,45	46,91	44,22	57,37	53,00	49,36	53,06	49,80
LB	57,98	56,99	55,29	54,07	55,85	52,83	48,85	48,44
LW	60,09	51,33	53,53	67,78	70,41	62,45	61,14	67,11

Table 1. Eurocontrol Member States' National Unit Rates in € (EUROCONTROL CRCO)

In these years, we may notice a huge variability in the unit rate values per charging zone ranging from about 20 € to nearly 100 €. Geographical proximity does not seem to influence unit rates. For instance, neighbouring United Kingdom (EG) and Ireland (EI) are on the opposite ends of the graph. Similar considerations also apply for Slovenia (LJ) and Hungary (LH) which are neighbouring eastern European countries of comparable size (LJ unit rate is generally twice larger than LH one). We notice that UK, which is the only country implementing a price-cap mechanism to set the en route unit rate, has the most stable value over the years (variations are within 5%). On the other side, Cyprus (LC) experienced the highest variation in percentage terms (81%) and Belgium (EB) in absolute terms (€ 35). Figure 2 describes for each state the percentage variation of the unit rate from year 2000 to 2007. We see a very dissimilar behaviour among the different states: for instance, Turkey (LT) show the higher decrease (-32%) from 2000 to 2007 while Greece (LG) and Cyprus (LC) have increased their unit rates about 50% in the same years. In summary, in 18 out of 28 charging zones it costs more to fly one en route service unit in year 2007 with respect to year 2000 whereas in 10 other ones it costs less. From Table 1 we notice that fluctuations in either directions over the years occurred for all states but Continental Spain (LE) which is the only one that has constantly increased its unit rate. Table 2 shows the average of 28 en route charging zone unit rates as of January from years 2000 to 2007. We observe that an abrupt increase (21%) occurred from year 2002 to 2003. The reason is that due to the economic downturn and the 11 September terrorist attacks, in 2001 and 2002 traffic (i.e., service units) was below forecast figures thus leading most ANSPs to under recover their costs. Hence, the need for them to augment their unit rates in the following years.

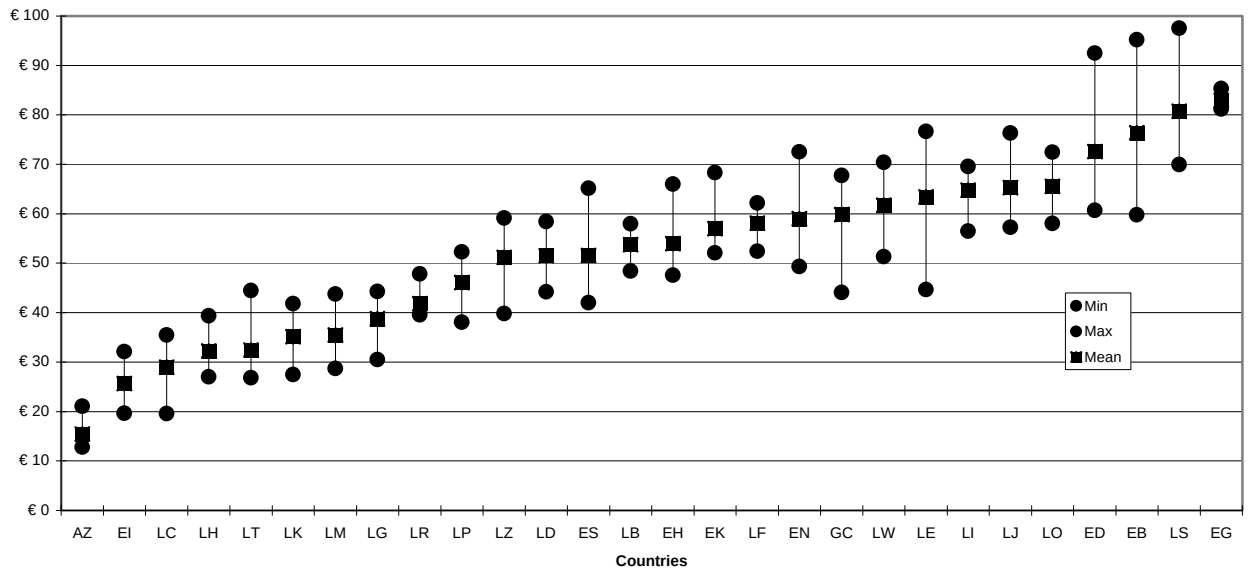

Figure 1. Minimum, maximum and mean en route unit rates from year 2000 to 2007

Year	Av. UR	Year	Av. UR
2000	€ 47,99	2004	€ 57,40
2001	€ 49,29	2005	€ 53,15
2002	€ 48,78	2006	€ 50,49
2003	€ 59,03	2007	€ 51,52

Table 2. 2000 to 2007 average en route unit rate (UR)

As already mentioned, the unit rate value is calculated by dividing the forecast costs for air navigation services by the forecast number of chargeable service units. Hence, we conclude that the costs per service unit of providing air navigation en route services are subject to significant variations among different charging zones, and between two subsequent years for the same charging zone.

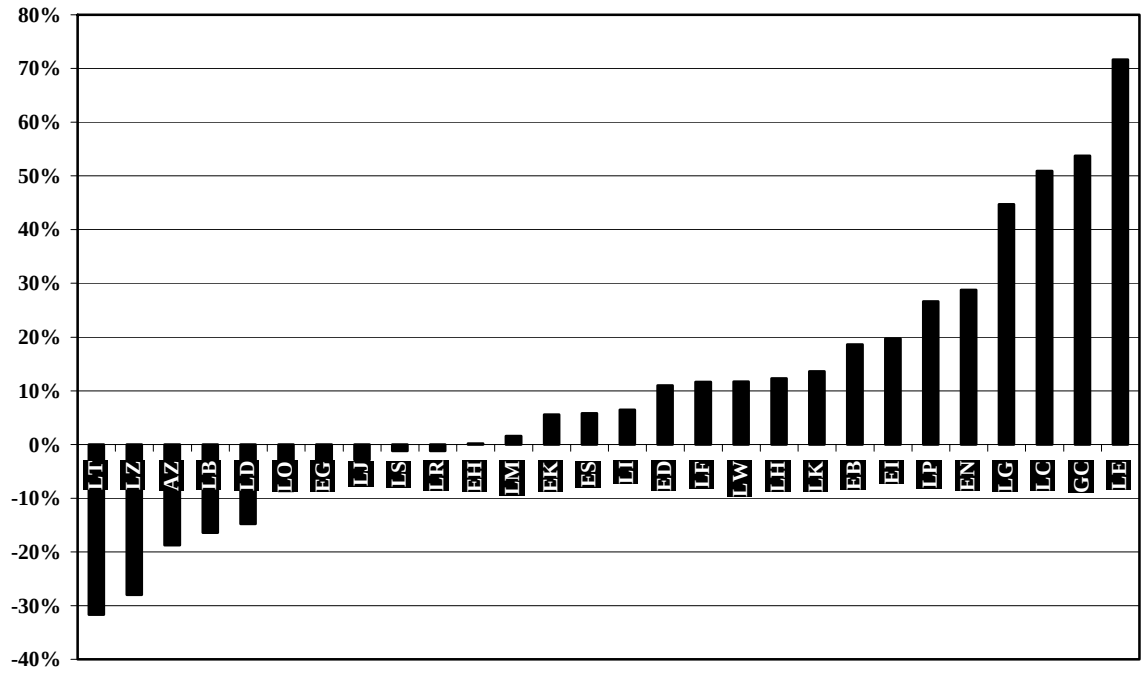

Figure 2. Percentage unit rate variation from year 2000 to 2007

Air navigation service charges on ANSPs

In all countries but United Kingdom, Lithuania, Latvia and Estonia [1] the Full Cost Recovery principle holds: all the costs incurred by ANSPs to provide air navigation en route service charges are completely recovered through en route charges. These costs are detailed either by nature, i.e., staff, depreciation, etc. or by service, i.e., air traffic management, communication, surveillance etc. (Annex II of the Regulation). We identify two main reasons why the costs per en route service unit for providing air navigation en route services are subject to large variations from country to country.

First, complexity. The EUROCONTROL Performance Review Commission released in April 2006 a report where complexity is defined as '*the external factors that impact the controller workload and/or the level of difficulty of the ATC task, without considering the internal, ATC procedures-related factors*' [4]. Some traffic complexity indicators both at ANSP and at ACC level have been defined and calculated relying on data from 2003. Figure 3 plots the en route unit rates in 2003 versus the Aggregated Complexity Indicator at ANSP level. We see that unit rates are higher where traffic is more complex. The opposite behviour is not necessarily true, i.e., ANSPs experiencing low complexity traffic may set medium-high unit rate values. Second, staff cost. In Europe, the cost of labor is far from homogeneous. Relying on 2004 data [1], we see that the correlation coefficient between the total and the staff costs related to en route services is equal to 0.99, and on average, staff accounts for 47% of such total cost. We also calculate that the correlation coefficient between the staff costs divided by the number of service units actually flown and the unit rates is equal to 0.80. In other words, unit rates are high (low) when the staff cost per service unit is high (low).

However, complexity and staff cost per service units can only partially explain the unit rate variations among the different countries. A regression analysis where the unit rates are the dependent variables and complexity and staff costs are the independent ones exhibits an adjusted R^2 of 0.71. In fact, other phenomena may have an influence on the determination of the cost base thus making difficult the comparison of the unit rates. First, cross-subsidizations exist: a few Member States do not directly charge users for the air navigation terminal services, but include the terminal related costs into the en route chargeable costs. In addition, ANSPs have other sources of revenue beside en route and terminal charges, such as, oceanic en route charges, payments from national Governments, charges levied for other services usually not related with ANS. ANSPs may have additional financing when their cash expenditures exceed their cash receipts from charges and reimbursements. Finally, a number of other mechanisms are occasionally used by ANSPs as a source of additional income: European Union fundings through, e.,g., TEN or PHARE programs, cross-border leasing, loan facilities provided by the European Investment Bank and interest receivable from cash and other balances [5].

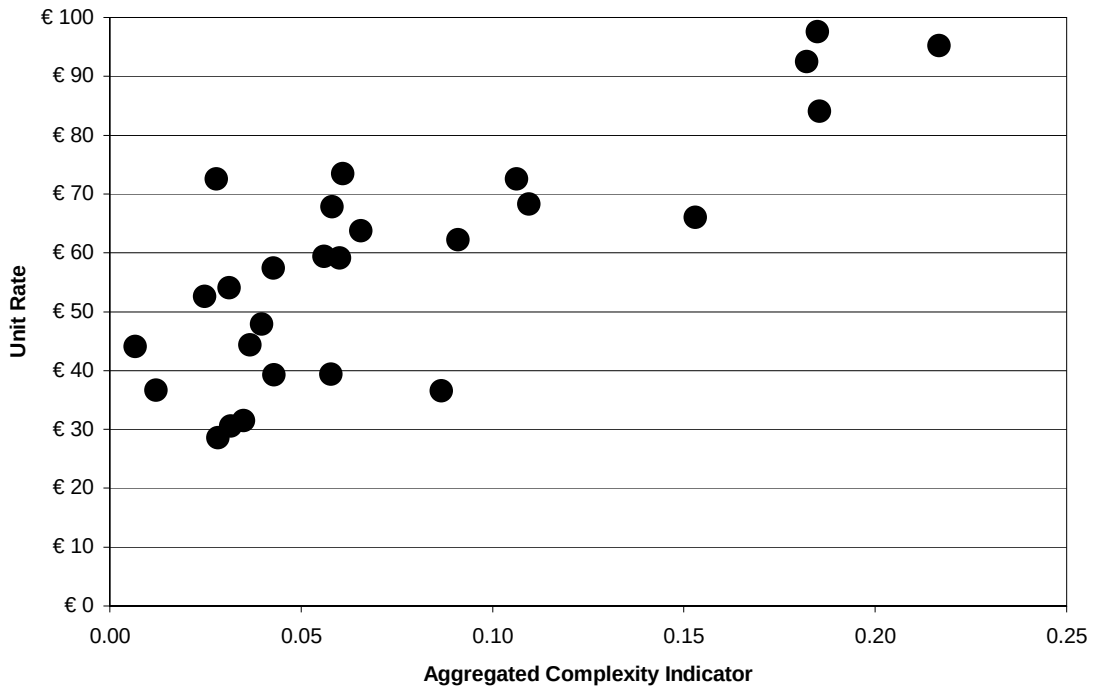

Figure 3: En route unit rates vs Aggregated Complexity Indicator per ANSP for year 2003

Table 3 shows the percentage of ANSP revenues in year 2004 disaggregated by en route charges, terminal charges and other sources of revenues, sorted in decresing order of other sources of revenues. Although these values significantly differ among contries, en route charges represent more than 70% of total revenues for 75% of providers. However, there is no evidence that unit rate values are related to other-than-charges sources of revenues: all six countries at both ends of the table (i.e., the three countries with highest and lowest percentage of revenues not related to charges, respectively) have low en route unit rates.

	En Route	Terminal	Other sources
LC	38%	8%	54%
LT	70%	0%	30%
LM	72%	0%	28%
EB	73%	0%	27%
LI	64%	9%	27%
LS	49%	27%	24%
EG	71%	11%	18%
ES	83%	0%	17%
LW	81%	5%	14%
EN	53%	33%	14%
LD	89%	0%	11%
LJ	89%	0%	11%
EK	72%	17%	11%
LO	72%	18%	10%
LZ	84%	7%	10%
ED	75%	17%	8%
LR	86%	7%	7%
LB	91%	2%	6%
EH	62%	32%	5%
LF	79%	16%	5%
LK	62%	33%	5%
EI	85%	13%	2%
LH	99%	0%	1%
LG	93%	7%	0%

Table 3: ANSP Revenue breakdown - Year 2004

We conclude that air navigation charges play a major role for ANSPs because they are their main source of income. Even though en route unit rate values are related to the traffic complexity and cost of labor, the low level of transparency provided by some ANSPs regarding the allocation of their costs does not allow to perform a meaningful benchmarking comparison between States/ANSPs. This fact affects all the studies performed in this area, as underlined in [1].

New features of the Regulation

The Regulation does not introduce any change in the formula to calculate en route charges, and in the mechanism to bill and collect them. In particular, it preserves several features that have been generally considered as positive assets of the European system for financing the provision of air navigation services:

1. Non-discrimination based on the nationality of the airspace user. However, as underlined by the Association of European Airlines (AEA) in different circumstances, some airlines may have substantial benefits by the way ANSPs allocate their costs, e.g., if meteorological costs are levied to en route instead of terminal charges, carriers operating on that airport (homebased carriers) take clear advantage.
2. Users are charged according to their ability to pay: the presence of the weight factor into the charging formula is in line with Ramsey pricing principles for the efficient recovery of fixed costs and has been generally acknowledged as a proxy for users' ability to pay [6]. Nevertheless, other studies affirm that a better proxy for the ability to pay would be the seating capacity of an aircraft, which has been proved to be related to the MTOW by a factor 0.7 [7].
3. A unique charging system, i.e., the calculation of air navigation service charges follows the same rules in (nearly) the whole Europe.
4. Simplicity of the system of calculating en route charges through a single formula, and their collection through a unique organization such as EUROCONTROL CRCO.

On the other side, the Regulation aims at going over the main shortcomings of the previous charging system.

The European Commission and EUROCONTROL [8] stated that the absence of incentives for both system users and providers to optimize the use of existing capacity, or to respond to signal to invest in new capacity, was one of the main weaknesses of the previous charging system. Article 12 of the Regulation explicitly allows Member States *to establish or approve incentive schemes […] to support improvements in the provision of air navigation services […]. These incentives may apply to air navigation service providers and/or airspace users*. If the incentive scheme is limited in time, scope and amount, a Member State may modulate air navigation service charges, e.g., night-time charged differently from daylight-time, *decreased charges according to airborne equipment that increases capacity or to offsetting the inconvenience of choosing less congested routes*, […] *to optimize the use of air navigation services, to reduce the overall costs of these services and to increase their efficiency*. Nevertheless, the adoption of measures incentiving airspace users to avoid congested areas (spatial differentiation) or congested times (peak differentiation) may have limited impact on airlines behaviour. In fact, on one side there is evidence that in some circumstances en route charges are the cost factor driving airline operators to prefer longer routes but cheaper in terms of en route charges [9]. On the other side, we also showed [10] that traffic demand is inelastic with respect to en route charges. In addition, most passengers travelling during congested hours and areas are business customers whose willingness to pay is generally insensitive to ticket fares. Hence, airlines might easily compensate an increased burden of air navigation service charges through an appropriate ticket pricing. However, some low cost and charter airlines may operate flights at less congested times and/or airspaces if peak pricing would be introduced.

The lack of transparency in establishing the annual forecasts for ANSPs' cost bases and the lack of consultation with airspace users were other causes of major concern of the previous charging system. Articles 8 and 15 of the Regulation deal with both issues by ensuring consultation with airspace users on the charging policy on a regular basis and by granting to them the disclosure of the necessary information on ANSP decisions on their cost bases, planned investments, expected traffic and charging mechanism. This transparency policy should also enforce ANSPs to improve the control of their costs thus providing further support to the already existing trend of decreasing en route unit costs [11].

Finally, the obligation for ANSPs to introduce terminal charges will improve cost-reflectivity, i.e., there will be better correlation between the operational phases of control and types of charges levied.

Air navigation service charges on airspace users

Airspace users (or aircraft operators) pay air navigation service charges. Since the vast majority of charged flights are performed by regular airlines or carriers, in the remainder of the paper we consider airspace users (or aircraft operators) as synonymous of airlines (or carriers), unless otherwise specified. In this section, we analyse the impact that air navigation service charges have on airline strategies and operations.

Table 4 shows the air navigation service charges percentage of total operating costs for some European airlines, which published financial results for 2005, including en route charges amount voice. We observe that the impact of such unavoidable charges significantly differs in accordance with the airline cost structure: low cost carriers (EasyJet and Ryanair) are more affected than legacy carriers because of their simplified services offered to passengers thus reducing as much as possible their

costs. As already mentioned in the introduction, the Association of European Airlines (AEA) claims that air navigation service charges account for 9% of direct operating costs of its members in 2005. Similar findings are reported in [12]: air navigation service charges represent from 2% to 6% of aircraft operating costs, with the lower percentage applied to long haul flights (possibly over oceans) and the higher percentage related to regional flights that often face congestion and operational inefficiency problems.

Airline	Total operating costs FY2005	En route charges amount	Share
Austrian Airlines	2585,8 €m	126,6 €m	4,9%
EasyJet	1132,5 £m	108,6 £m	9,6%
Iberia	4823,2 €m	276,4 €m	5,7%
Ryanair	1007,1 €m	135,7 €m	13,5%

Table 4: Route Charges vs. total operating costs for some companies

Air navigation service charges on airline strategies

The take-off of a specific aircraft at a given time in a given airport is the outcome of a long planning process that may have started several months before. The aim of such process, generally referred to as schedule planning, is to maximize airline profitability [13]. Its main steps are the identification of which Origin-Destination pairs to connect, the frequency of departures and allocation to specific timings based on market preferences, the type and capacity of aircraft to be used, and the number of passengers to serve [14].

In principle, the level of air navigation service charges may have an impact on such decisions. Nevertheless, long-term planning on which markets to serve generally depends on macro-economic factors as forecast of GDP, which is the main driver for passenger growth, location and other market features. Other studies show that the number of flights and passenger demand are inelastic with respect to en route charges [10].

However, the fact that airlines and passengers have such an inelastic attitude does not necessarily imply that airlines have to be indifferent to variations to route charges. In fact, profit margins may be often very low, so even tiny percent cost variations may have a high impact on profits. In particular, even limited perturbations of en route charges often have an impact on low-cost carriers, because such companies have already optimized the other components of the operating costs that are directly manageable.

Hence the need to understand whether airlines have the opportunity to reduce the burden of air navigation service charge on their balance sheets.

Air navigation service charges on airline operations

Following airline cost classification in [14], air navigation service charges are direct variable operating costs along with fuel and oil consumption, airport fees, maintenance and crew costs. More specifically, terminal charges depend on the schedule design and fleet assignment phases where the departure and arrival aerodromes together with the type of aircraft are decided. So far, terminal unit rates, when they exist, are generally the same for each aerodrome of a specific country. Hence, they have no impact on any schedule design because their magnitude is too low to influence airline's decisions on which countries to fly. However, in accordance with the Regulation, any ANSP may set different terminal unit rates for different airports or groups of airports. It follows that in the future terminal charges may become a driver, as airport fees are today, for airlines to select which airport to serve. There is also no evidence that the limited level of terminal charges may have any influence on airline decisions on which aircraft to use.

On the other side, en route charges have influence on the airspace routes actually flown. Indeed, aircraft are not allowed to freely fly in the European airspace, but are constrained to follow, at least in principle, a sequence of ATC points from the departure to the destination aerodrome. The flight level and the time each ATC point is crossed, along with other relevant information, are recorded in the Flight Plan that must be approved by EUROCONTROL Central Flow Management Unit (CFMU) before the aircraft actually takes off. We distinguish three phases: strategic (from several months until two days before the flight), pre-tactical (two days before the day of operations) and tactical (in the day of the departure of the flight) planning. In the strategic planning phase aircraft operators submit to CFMU flight plans representing – to the best of their knowledge – their preferred route choice for connecting the specified departure and destination aerodrome using the specified aircraft. In other words, any flight plan sent to CFMU in the strategic phase indicates the aircraft trajectory (both in the 3D space and in time) the airline would like to follow in the actual day of flight operations. In building such an "optimal" route, aircraft operators minimise all the predictable costs associated to the flight: any unexpected event (like, e.g., weather conditions or delays) that would possibly occur is not taken into account and is considered in the pre-tactical and tactical phases.

The factors producing predictable route cost changes when alternative routes are under investigation are fuel, en route charges, maintenance, and crew costs. Even though the route design process is also influenced by some other factors such as, e.g., mean delay in some airspace, frequency of restrictions in airspace, and quality of service obtained by ANSP, a few studies [9,15] show that en route charges have influence on the airline choice of the airspace route to be flown when connecting a specific origin and destination pair. More precisely, due to the high variability of en route unit rates among different countries, there is evidence that in the strategic planning phase airlines, when alternatives exist, may prefer to fly longer routes (thus spending more in terms of fuel, maintenance and crew costs) but cheaper in terms of en route charges to minimize their predictable route costs. We claim that this is an undesirable effect of the present system since airline costs increase due to higher fuel consumption, higher crew utilisation and maintenance costs. In addition, also pollution rises. Thus to some extent the present route charging scheme does not promote the best use of the available airspace because airlines may fly longer to mitigate the impact of en route charges. There is also evidence that delays and regulations affect airlines' route choice. From a theoretical point of view, the introduction of the cost of the delay reduces the influence that en route charges may have on route choice. In [16] authors give an empirical proof of the weaker impact of route charges on airlines' behaviour when delays or en-route congestions occur.

En route charges vs. fuel costs

We compare en route charges with fuel costs for various categories of aircraft, as indicated in Table 5.

	A380	B747 -400	B757 -200	A319	CRJ 200	EMB 120
MTOW (t)	560	395	113	68	24	12
Weight Factor	3,35	2,81	1,50	1,17	0,69	0,49
Fuel Cons. (Kl/h)	16,9	12,8	4,2	2,6	1,2	0,63
Cruise speed (km/h)	1013	927	903	853	785	555

Table 5: Aircraft characteristics.

The jet fuel price has been calculated using global average value calculated by IATA for the week 12-19 January 2007 (Source: http://www.iata.org/whatwedo/economics/fuel_monitor/index.htm), corresponding to 0,436 $/l, equivalent to 0,3373 €/l (according to Euro exchange rate as at 18th January 2007, published by European Central Bank). Nevertheless, this price is indicative as airlines negotiate their own fuel prices that largely vary from place to place and from airline to airline. In addition, this price does not exactly track the price of a barrel of oil because fuel is generally bought in advance on the futures market in a process called hedging.

	A380	B747 - 400	B757 - 200	A319	CRJ 200	EMB 120
Fuel Cost	5,63	4,66	1,57	1,03	0,52	0,38

Table 6: Fuel Cost per km (€/km).

Figure 4 shows the ratio obtained by dividing en route charge cost per km by fuel cost per km (Table 6), for different values of en route unit rates.

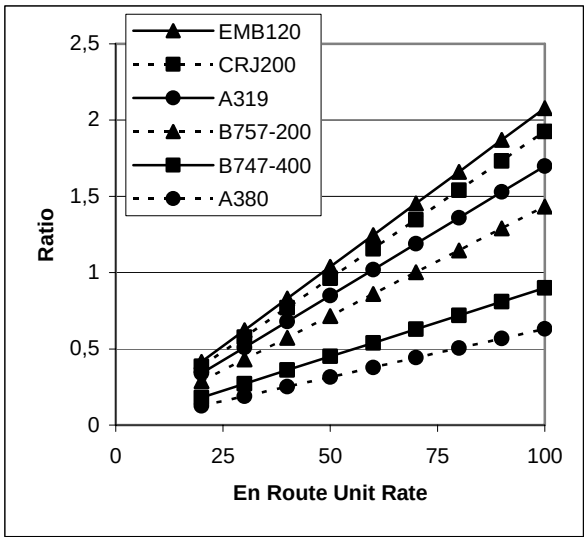

Figure 4: En route charge Cost/Fuel Cost per km per aircraft type.

Considering the average unit rate in 2007 equal to 51,52 € (Table 2), we claim that for small aircraft en route charges have almost the same magnitude per km as fuel costs, while for larger aircraft en route charges should almost double before being equal to fuel costs. This result demonstrates that the cost of en route route charges is not insignificant, expecially for small aircrafts.

Air navigation service charges on passengers

Since air navigation service charges represent a non-negligible fraction of variable direct operating costs of airlines, they are also likely to affect passenger ticket price. Unfortunately, it is not straightforward to estimate such impact because they are not charged directly to passengers by any taxes and fees, as airport fees or fuel surcharges, but are implicitly included in the base fare ticket. This is a major difference with the U.S., where the federal ticket (7.5% of the base fare ticket price)

and segment taxes ($ 3.30 per passenger per domestic segment – a segment is a flight leg consisting of one take off and one landing by a flight) are used in part to fund the Federal Aviation Administration's air traffic control operations [17]. Some preliminary results suggest that air navigation service charges account for about 6% [3] or 7% [17] of the base fare ticket. Because of this limited impact, other studies conclude [10] that ticket prices are inelastic with respect to limited variations of air navigation service charges.

The way forward

In recent years, a great effort has been undertaken at European level to move from the traditional national approach of airspace organisation and management towards a more integrated European system. In 2006 the Performance Review Coomission considers that "*there are significant performace shortfalls in European ANS at present: [..] Low cost-effectiveness, linked with ANS fragmentation and low average productivity, and relatively high flight-inefficiency, linked with civil-military airspace design and use*." It also follows that the European ATM system is much less cost-effective than the U.S one, as shown in Table 7 [11].

	U.S.FAA	**EUROCONTROL area**
Gate-to-gate ANS costs (without MET)	$7.9 * 10^9$ US$	$6.6 * 10^9$ €
IFR flights	$18 * 10^6$	$8{,}9 * 10^6$
Cost per IFR flight	440 US$ (386 €)	742 €

Table 7: High level comparison of US versus Europe cost-effectiveness (2004)

The difference of 92% in the cost per flight is mainly due to two causes [18]. On the one hand, US controllers can handle more traffic because they are employed with greater flexibility depending on the traffic variations, there is a better coordination between civil and military and the uniformity of US system make it easier to manage handovers between ACCs. On the other hand, the support costs (particularly the costs for non-ATCO staff) in certain European centres is notably higher than in the US.

To overcome the problems and deficiencies linked to a fragmented management of the air transport system, the European Commission proposed a regulatory approach with the objective of achieving a Single European Sky (SES). In this context, one of the building blocks of the whole SES is the reconfiguration of the European Upper Airspace (FL285) into Functional Airspace Blocks (FABs). These are cross-border airspaces optimized on the base of operational requirements rather than national boundaries to improve capacity, enhance security and lower costs of air traffic services. At the time being, several initiatives exist among ANSPs across Europe to investigate the feasibility for an eventual implementation of one or more FABs. Moreover, in the process of establishing a FAB a major decision is related to the charging scheme to be adopted. Since charging zones have to *be defined in a manner consistent with air traffic control operations and services* (Article 4 of the Regulation), it would be natural to consider a FAB as a unique charging zone. The possibility to set different en route unit rates between upper and lower airspace would reflect the different costs and cost drivers associated with the use of the respective ANSP resources concerned, and the trend towards organizational separation in service provision between upper and lower airspace. However, as some preliminary studies suggest [19], the vertical differentiation of en route unit rates would adversely affect regional and region-based airlines because they perform short flights, often almost entirely in the lower airspace. In fact, in some European areas between 70% and 90% of en route service units is generated in the upper airspace, thus leading to a significantly lower en route unit rates for the upper airspace than the corresponding ones for the lower airspace.

Hence the need to devise charging schemes that both comply with the future cross-border and integrated architecture of European air traffic management and take into account airspace users' requirements.

Conclusions

This paper makes an overview of the main characteristics of air navigation service charges that are the major source of revenue of any European ANSP. We show that the cost for providing air navigation service has huge variations across Europe. Further investigations and more transparency on ANSP cost allocation are required to understand this phenomenon. The amount of air navigation service charges affect airspace users, notably airlines, as a non-negligible fraction of their variable direct operating costs, and in the choice of the route to be actually flown in the airspace. According to some preliminary studies, there is also evidence that air navigation service charges have an impact on the price of passenger ticket. Finally, the implementation of Functional Airspace Blocks in the upper European airspace in accordance with the Single European Sky policy fosters the need to develop innovative charging schemes where also incentive mechanisms may be outlined.

Appendix

ICAO Code	Country	ICAO Code	Country
EB	Belgium	LM	Malta
ED	Germany	LI	Italy
LF	France	LC	Cyprus
EG	United Kingdom	LH	Hungary
EH	Netherlands	EN	Norway
EI	Ireland	EK	Denmark
LS	Switzerland	LJ	Slovenia
LP	Portugal	LR	Romania
LO	Austria	LK	Czech Republic
LE	Continental Spain	ES	Sweden
GC	Canary Islands	LZ	Slovakia
AZ	Portugal Santa Maria	LD	Croatia
LG	Greece	LB	Bulgaria
LT	Turkey	LW	Macedonia

Table A. ICAO Country Codes

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Air navigation charges, air traffic management, economic analysis.

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