The incidence of indirect unit taxes on airfares – Empirical evidence from Germany

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Abstract

We investigate the effect of the German Air Traffic Tax Act (GATTA) of 2011 on airfares by applying a difference-in-differences estimation strategy on a reduced-price function. Our analysis is based on a comparison of the German and French monthly consumer price index on passenger airfares (CPIAF) over the period 2005–2011. We find that the tax reform significantly raised the average airfares in Germany. The result is robust to alternative specifications.

Keywords: tax policy, tax incidence, airfare, air transport demand
JEL classification: H22, L93, L98

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1 Introduction

Each passenger flight that departs from an airport within Germany is levied a tax. To increase government revenue and ostensibly to protect the environment by internalizing the social costs associated with flying, a new German Air Traffic Tax Act (GATTA)[1] was enacted on December 9, 2010 and took effect on January 1, 2011. Expectedly, affected passenger carriers protested against the tax. Low-cost airlines, in particular, are claim that their segment of the market is sensitive to marginal changes in ticket prices and that the increase attributable to the tax will eventually translate to a loss of market share. Whereas established network-carriers admit that they will not be able to pass on the tax charges to its passengers, meaning the financial burden will be met by the airlines.

The design and implementation of this specific quantity or excise tax gives rise to a natural experiment that allows us to estimate the effect of the tax on consumer prices. In particular, the tax affected all passenger air traffic departing from Germany so we are able to use the neighboring country of France as a comparison. Moreover, the tax was levied only on passenger traffic but not on freight traffic; this makes the latter an alternative control group.

The subsequent sections begin with an overview of the GATTA. By using a reduced price function in a regression formulation of the difference-in-difference approach (DiD) and the data for German and French consumer price index on passenger airfares (CPIAF) over the monthly period of 2005 to 2011 the paper quantifies the average effects of the GATTA on airfares. The results allow for an ex-post evaluation of the reform.

2 The GATTA

The central argument in favor of taxes on aviation is to account primarily for environmental externalities.[2] The proponents of the GATTA indeed motivated its introduction with the Pigouvian properties of such a tax, i.e., that it eliminates the divergence between the private and the social (environmental) cost.

Airlines bear the statutory burden of the tax—that is, they collect the revenue which they eventually remit to the government. The tax is differentiated according to the distance traveled. Airlines pay € 8 per passenger for flights in Europe, € 25 per passenger for flights

[1] In German, *Luftverkehrsteuergesetz* (*LuftVStG*). Article 24 of the law was in force earlier, specifically on December 15, 2010.

[2] In addition, passenger travel is a final good and is therefore less likely to cause distortions in the production chain when taxed. For a systematic overview of aviation taxes, see Keen and Strand (2006).

between a range of 2,500 to 6,000 km, and € 45 per passenger with a flight distance above 6000 km.[3]

Other countries have also introduced a similar tax. In the Netherlands, for example, the "eco-ticket tax" was introduced in July 2008 but was abolished after only one year in 2009 due to drops in passenger numbers.

As a reaction to the GATTA, the aviation industry (including airport authorities) highlighted the potential negative impact the tax could have on the German aviation market. The analysis is based on the assumption that the degree of competition in air transportation—among airlines, between airlines and other modes of transport (e.g., train, car), and among airports—is high. As consequence, airlines produce at slightly above marginal costs and additional charges have to be reflected on the ticket price. In reaction, consumers will reduce the quantity demanded and may use competing transportation modes or alternative airports.

3 Research Design and Data

We apply a difference-in-differences (DID) estimation strategy to estimate the impact of the GATTA on airfares. We characterize how this strategy applies in this case and then subsequently describe the data we use.

3.1 Comparison Country

Ideally, one must randomize treatment and compare the mean outcome of the treatment group to the control group to have an estimate of the effect of treatment. However, it is difficult to randomize an air traffic tax at the level of countries. Nevertheless, we are able to define a suitable control group for Germany to study the impact of GATTA on the consumer airfare index.

France seems to be the ideal candidate to serve as the control group to analyze the reform's effect on Germany's airfares. France is not only comparable to Germany in terms of the economic structure and macroeconomic situation but their air transportation markets are similar in many respects. Indeed, there is no other European country with a better comparable macroeconomic and demographic situation. In addition we assume that the degree of intermodal and intramodal transport competition is developed to the same extent.[4] Table A.2.2 to A.2.5 show the development for passenger numbers in aviation for Germany, France and

[3] Due to the accession of the aviation sector to the European Emissions Trading scheme, the German government lowered the rates by 5.52 percent in 2012. However, this does not affect the analysis in the present manuscript because we examine data only until 2011.

[4] This needs further verification and research contrasting key figures as for example the mark-up of low-cost carriers, revenue, and available seat kilometers, capacity, etc.

Spain. They similar development over the period of 2003 to 2010 let us assume that the aviation markets are comparable.

Figure A.3.1 shows the development of the price indicator for passenger airfares (CPIAF) for France Germany and Spain between January 2005 and November 2011. The drift between the indices starts in the last quarter of 2010 whereas before, they demonstrate the same characteristics. That underlines our assumption necessary for applying a difference-in-differences method. Without the policy reform the indicators would follow the same trend. In addition to only consider France as a control group we conduct a second estimation using Spain as a control group.[5]

3.2 Data

Our empirical analysis is based on data aggregated at the country level collected from Eurostat and the national statistical offices of each country. The dataset contains monthly information for the years 2005–2011. We limit our period to exclude other institutional changes affecting the price of air transportation in the countries such as the liberalization of the European air transport market.[6] We use the consumer price index for passenger airfaires as our dependent variable and different price indicators to control for other price developments between the countries. The GDP per capita plays a significant role in the demand of air transportation (Bhadra 2002). Since it is not available on a monthly basis, we choose the production index as a proxy instead of a disaggregation of the quarterly data. To control for another demand variable we use the unemployment rate.

On the supply side, we account for the two main cost drivers for airline companies: wages and fuel prices.[7] For the former, we use the producer cost index excluding energy collected by Eurostat. The latter is represented by the spot price of jet fuel collected from the Energy Information Administration (EIA). Having only one jet fuel price for all companies seems reasonable to us since we look at changes at country level. We assume that all airline companies are obliged to hedge fuel in order to smooth their cost structure over time. Even if there might be gains and losses from hedging, which may lead to different cost structures between airlines, this difference would be unaffected by the introduction of the GATTA. The same reason holds for a possible difference in fuel consumption of the fleet between airlines.

[5] Another approach considered by the authors at a later stage is to adopt the approach of Abadie, Diamond and Hainmuller (2010) which use a combination of untreated units (synthetic controls) in order to find a better comparison country/group.

[6] See Button (2001). We excluded the transition period form a regulated to a liberalized market and assumed that seven years after the full liberalization today's market structure and competition level were established.

[7] See The German Air Transport Initiative (2001), pp. 78.

Therefore, by construction, the jet fuel cannot explain the different development in price for passenger airfares between the countries and could be left out of the model.

4 Econometric Model and Estimation Results

We use the introduction of the GATTA as natural experiment and apply a difference in differences estimation. The important assumption of this approach is that in the absence of the policy (GATTA) the airfares for Germany and France follow the same trend.

We use a simple reduced-form price function following Karlsson (2006) and Alm, Sennoga and Skidmore (2009). We express the CPIAF, denoted by *prc*, in logarithm in the following DID estimation equation:

$$\ln prc_{ij} = \alpha + \beta_1 treat_i + \beta_2 \ln prdc\_prc_{ij} + \beta_3 \ln prdc\_id_{ij} + \beta_4 DiD_{ij} + \beta_5 unempl_{ij} + \beta_5 fuel_j + \beta_6 year + \beta_7 period_i + \varepsilon_{ij}$$

where i indexes countries and j the months. The indicator variable $treat$ equals 1 for Germany (treatment group) and 0 for France (control group). The variable $period$ is a time fixed effect and is equal to 1 if the observation month falls after the GATTA and equals 0 if it is before the reform. The DiD_{ij} is defined as the interaction between the treatment indicator and the post-reform indicator. The coefficient is our variable of interest and captures and average effect on the German price for airfares.

We also augment the equation with additional covariates to capture developments on the supply side. More explicitly, we introduce the production price index ($prdc\_prc$) and fuel costs. By adding the production volume index ($prdc\_id$) and the monthly unemployment rate ($unempl$) take into account additional variables of demand. The variable $year$ accounts for general time effects and ε_{ij} represents the error term. All indices are seasonally adjusted. Alternative models are used to evaluate our functional form and robustness.

The estimation results are presented in Table 1. We estimate that the introduction of GATTA increased the CPIAF in Germany by about 12 percent. This is the average treatment effect. The interpretation of this effect is not obvious since the dependent variable is a price index. A first simple approach is to relate the effect to the annual mean growth rate of the month in the previous year before the policy intervention. It turns out that the average treatment effect is four times higher than the annual growth rate before the intervention. This might lead to the preliminary conclusion that the additional costs are largely shifted onto to passengers.[8]

[8] *This overall effect could be the accumulated result of over- and under-shifting of the tax in different market segments with different degrees of competition.*

Our results are robust in the sense that we follow Bertrand, Duflo and Mullainathan (2004) and test for significance by changing the treatment period (placebo reform) and excluding the period after the real reform (2011). As expected the DiD becomes insignificant in this scenario. Despite the estimation with robust standard errors we test satisfactorily for autocorrelation for each country.

Table 1 – Difference-in-Differences Analysis; Basic Specification;
Dependent Variable: Log CPI Air Passenger Transportation

	OLS	OLS (robust SE)	OLS	OLS (robust SE)
Comparison Country	France	France	Spain	Spain
Treatment Group	0.00826	0.00826	-0.0328***	-0.0328***
	(0.015)	(0.0127)	(0.0089)	(0.00915)
Difference-in-Differences	0.121***	0.121***	0.126***	0.126***
	(0.0274)	(-0.0259)	(0.0237)	(0.0227)
Log. Production index	-0.161	-0.161	-0.278**	-0.278**
	(0.169)	(0.154)	(0.128)	(0.136)
Log. Production price	0.928***	0.928***	1.454***	1.454***
	(0.336)	(0.339)	(0.253)	(0.28)
Log. Fuel	0.0600*	0.06	0.0554*	0.0554*
	(0.0335)	(0.0376)	(0.0284)	(0.0304)
Unemployment rate	-0.0111*	-0.0111*	-0.00261	-0.00261
	(0.00656)	(0.00620)	(0.00196)	(0.00218)
Observations	165	165	165	165
R^2 adjusted	0.765	0.765	0.891	0.891

Notes: (i) Year dummies and a constant term are included in all estimates. (ii) Standard errors are reported in parentheses. (iii)*** significant at 1 percent level; ** significant at 5 percent level; * significant at 10 percent level. (iv) Columns (2) and (4) show results of the OLS estimation with robust standard errors.

The production volume index as expected, shows for both countries a negative influence but is only significant at the 5-percent level in the estimation with Spain. The production price has a positive effect on the price in all estimations and is significant. The unemployment rate was expected to have a negative impact on the price for air passenger transport since it lowers available income but shows small significance for the scenario with France.

5 Conclusion

We use a reduced price function in a regression formulation of the different-in-differences approach to quantify the effect the GATTA had on the airfares in Germany. Our current OLS estimations suggest that the GATTA had an average treatment effect on airfares in Germany of 12 percent in 2011 compared to the counterfactual situation without the reform. In relation to the annual growth rate of the index this might lead to the preliminary conclusion that overall the additional costs are largely passed on to the customers. This should be handled with care since we do not know how the CPIAF is weighted in terms of flights and prices. Our identification strategy and specifications, however, need to undergo robustness checks in further steps of the research. We need to strengthen our analysis by a more detailed analysis of the comparison countries and include or exchange other explanatory variables reflecting the supply side of the aviation sector. The simplified approach of our paper neglects the different levels of competition, price elasticities of demand and supply and therefore the possibilities of strategic pricing behavior or product differentiation especially airlines. Nonetheless, in order to evaluate the impact of the GATTA our analysis can be seen as a first step and adds to the empirical literature of tax incidence.

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Appendix

A.2 Tables

Table A.2.1 – Difference in Differences-Analysis complete results;
Dependent Variable: log CPI Air passenger transport

	OLS	OLS (robust SE)	OLS	OLS (robust SE)
Comparison Country	France	France	Spain	Spain
Treatment group	0.00826	0.00826	-0.0328***	-0.0328***
	(0.015)	-0.0127	-0.0089	-0.00915
Difference-in-Differences	0.121***	0.121***	0.126***	0.126***
	(0.0274)	-0.0259	-0.0237	-0.0227
Log. prdc id	-0.161	-0.161	-0.278**	-0.278**
	(0.169)	(0.154)	(0.128)	(0.136)
Log. prdc price	0.928***	0.928***	1.454***	1.454***
	(0.336)	(0.339)	(0.253)	(0.28)
Log. fuel	0.0600*	0.06	0.0554*	0.0554*
	(0.0335)	(0.0376)	(0.0284)	(0.0304)
Unemployment rate (unempl)	-0.0111*	-0.0111*	-0.00261	-0.00261
	(0.00656)	(0.0062)	(0.00196)	(0.00218)
dum_2005	0.027	0.027	0.0381	0.0381
	(0.0459)	(0.0443)	(0.0429)	(0.0435)
dum_2006	0.00221	0.00221	0.0206	0.0206
	(0.0353)	(0.034)	(0.033)	(0.0311)
dum_2007	-0.0123	-0.0123	0.0101	0.0101
	(0.0328)	(0.0294)	(0.0303)	(0.0259)
dum_2008	0.00301	0.00301	0.0263	0.0263
	(0.0229)	(0.0219)	(0.0217)	(0.0175)
dum_2009	0.101***	0.101***	0.0935***	0.0935***
	(0.0342)	(0.0323)	(0.0258)	(0.0242)
dum_2010	0.0659**	0.0659***	0.0699***	0.0699***
	(0.0263)	(0.0238)	(0.0214)	(0.0166)
Constant	1.136	1.136	-0.822	-0.822
	(2.001)	(1.927)	(1.429)	(1.529)
Observations	165	165	165	165
R-squared	0.782	0.782	0.899	0.899
Rank	13	13	13	13
ll_0	155.6	155.6	116.8	116.8
Ll	281.2	281.2	306.1	306.1
r2_a	0.765	0.765	0.891	0.891
Rss	0.32	0.32	0.236	0.236
Mss	1.145	1.145	2.108	2.108
Rmse	0.0458	0.0458	0.0394	0.0394
r2	0.782	0.782	0.899	0.899
F	45.41	44.99	112.9	226.1
df_r	152	152	152	152
df_m	12	12	12	12

Table A.2.2
Total Passengers (on board)
Passenger numbers in million

	Arrival			Departure		
Year	Germany	France	Spain	Germany	France	Spain
2003	72,96	61,42	76,64	72,66	61,50	75,27
2004	80,49	64,33	82,97	80,06	64,38	82,58
2005	85,57	67,17	89,39	85,24	67,22	89,85
2006	90,01	69,92	94,74	89,68	70,11	94,12
2007	95,49	73,50	103,78	95,11	73,52	103,27
2008	96,70	74,56	101,59	96,32	74,59	101,09
2009	92,54	71,66	93,25	92,28	71,62	92,96
2010	96,92	76,34	96,16	96,65	76,52	95,71

Source: Eurostat

Table A.2.3
National Passengers (on board)
Passenger numbers in million

	Arrival			Departure		
Year	Germany	France	Spain	Germany	France	Spain
2003	22,39	26,67	32,02	22,39	26,66	31,31
2004	22,44	26,34	35,27	22,44	26,34	34,82
2005	22,76	26,55	38,63	22,76	26,54	38,70
2006	23,37	26,92	41,05	23,37	26,92	41,05
2007	24,76	27,09	44,26	24,76	27,09	44,26
2008	25,25	26,68	40,62	25,25	26,68	40,61
2009	24,21	25,87	37,39	24,21	25,86	37,39
2010	24,77	26,73	38,08	24,77	26,97	38,08

Source: Eurostat

Table A.2.4
Intra-EU Passengers (on board)
Passenger numbers in million

	Arrival			Departure		
Year	Germany	France	Spain	Germany	France	Spain
2003	28,11	18,28	38,54	27,94	18,44	38,27
2004	33,98	20,36	41,21	33,70	20,54	41,45
2005	37,30	21,44	43,52	37,03	21,56	43,98
2006	40,37	23,14	45,27	40,06	23,28	44,91
2007	43,17	25,42	50,28	42,90	25,55	49,90
2008	43,01	25,98	50,71	42,75	26,12	50,46
2009	40,41	24,31	46,23	40,21	24,46	46,02
2010	41,78	25,88	47,22	41,62	26,07	46,84

Source: Eurostat

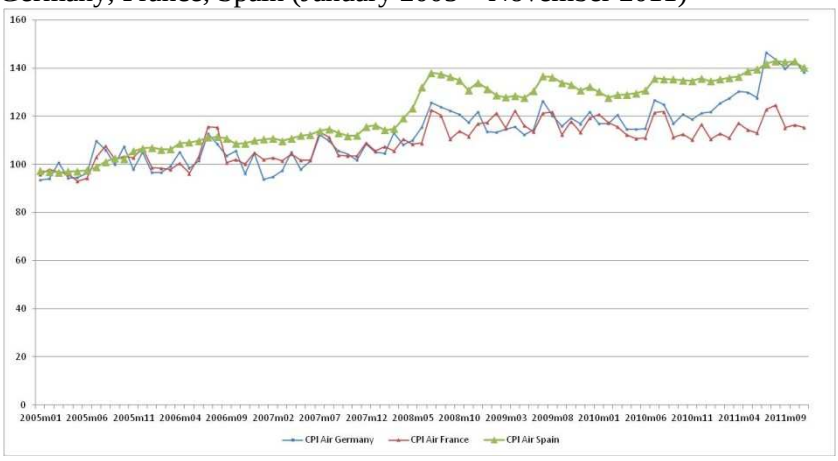
Table A.2.5
Extra-EU Passengers (on board)
Passenger numbers in million

	Arrival			Departure		
Year	Germany	France	Spain	Germany	France	Spain
2003	22,47	16,47	6,07	22,33	16,40	5,69
2004	24,07	17,63	6,49	23,92	17,50	6,31
2005	25,52	19,18	7,24	25,46	19,12	7,17
2006	26,26	19,85	8,42	26,25	19,92	8,16
2007	27,56	20,99	9,24	27,45	20,88	9,12
2008	28,44	21,90	10,26	28,32	21,79	10,02
2009	27,93	21,48	9,64	27,87	21,31	9,56
2010	30,36	23,73	10,86	30,26	23,48	10,79

Source: Eurostat

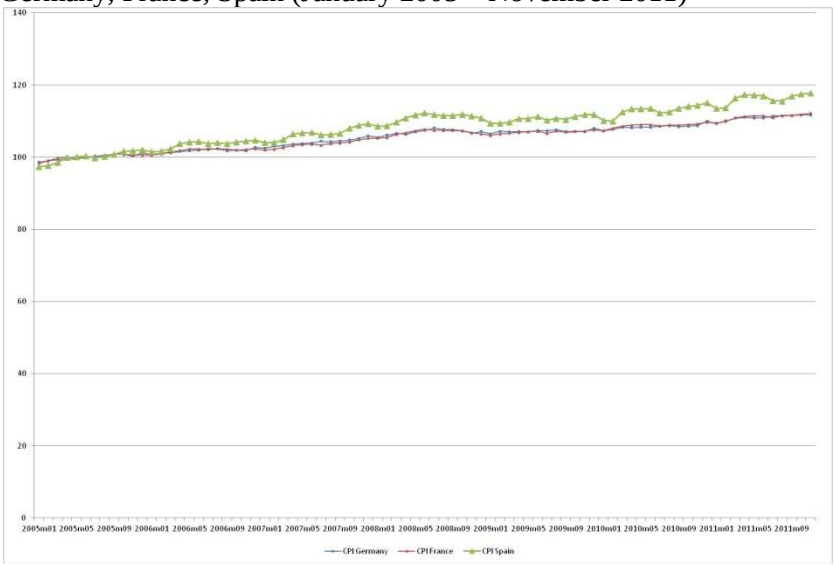
A.3 Figures

Figure A.3.1
Consumer Price Index on Passenger Air Fares
Germany, France, Spain (January 2005 – November 2011)



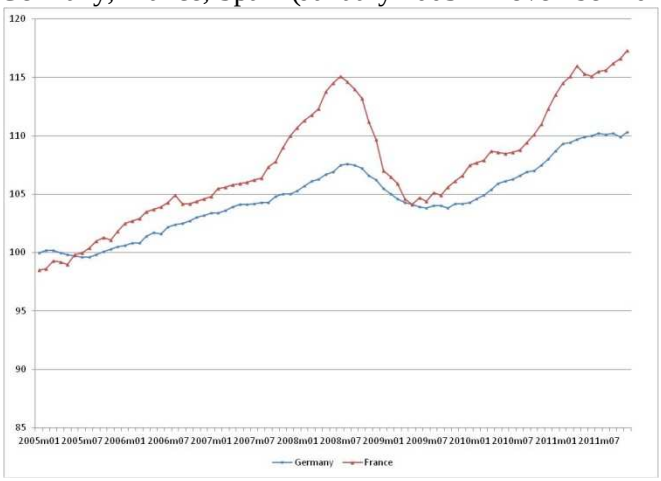
Source: Eurostat

Figure A.3.2
Consumer Price Index
Germany, France, Spain (January 2005 – November 2011)



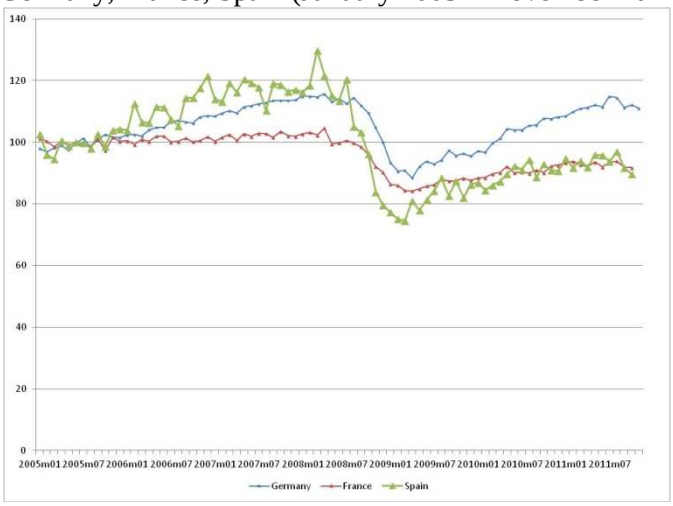
Source: Eurostat

Figure A.3.3
Producer Price excluding Energy, seasonally adjusted
Germany, France, Spain (January 2005 – November 2011)



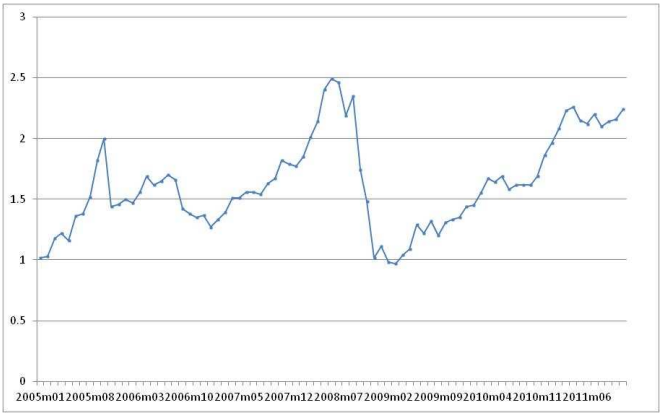
Source: Eurostat

Figure A.3.4
Production Volume Index, seasonally adjusted
Germany, France, Spain (January 2005 – November 2011)



Source: Deutsche Bundesbank/INSEE

Figure A.3.5
Jet Fuel spot price
in €/Gallon



Source: EIA

Box 1 Ticket Taxes in selected European countries

Austria

Austria introduced a ticket tax in April 2011 almost similar to the GATTA. Domestic flights cost 8 € (incl. VAT) as well as short-haul flights 8 €, Middle distance are taxed at 20 € and long-haul flights cost 35 € per passenger.

France

Tax de solidarité (TDS) since July 2006. It is 1 € inside Europe and 4 € outside of Europe for economy class passengers and tenfold the amount for non-economy passengers. The revenue was determined by law to the millennium target for poor countries (UNITAID).

Civil Aviation Tax was already created on the 1st of January 1999 in order to replace the "Security and Safety Tax" and the "Air Transport Adjustment Tax". Since January 2011 the rates for boarding are 4.17 € per passengers to destinations within any European Country, within European Economic Area Agreement and to Switzerland; 7.49 € per passengers to destinations within others States,1.25 € per tons of freight to mail (to any destinations). The rates get yearly adjusted by the growth of the index of consumer prices (excluding tobacco).

Netherlands

The Dutch government introduced a ticket tax in July 2008 which was called an eco-plan and abolished in 2009 after significant drops in air passengers especially those close to airports in Germany and Belgium who at that time, did not have tax on tickets.

UK

The tax was gradually raised and differentiated towards distance. At this moment the tax is 12 £ for a short haul flight (< 2000 miles) and 85 £ for a long haul flight (>6000 miles). For non-economy passengers the double is payable.

Source: IATA