Measuring marginal values of noise disturbance from air traffic: Does the time of the day matter?

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Abstract

This paper analyzes the marginal willingness to pay for changes in noise levels related to changes in the volume of flight movements at a city airport in Stockholm, Sweden, by using a choice experiment. When estimating marginal willingness to pay for different times of the day and days of the week, we find that these vary with the temporal dimensions: mornings and evenings have higher marginal values. Interestingly, a substantial proportion of the respondents prefer no changes in the current noise level. The paper concludes with a policy discussion related to incentive-based pricing.

JEL classification: D62, H23, Q51, Q53

Key words: Choice experiment, discrete choice, noise, airport

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1. Introduction

Neither domestic nor international air traffic has grown in the last few years, mainly due to economic recession and the backwash of September 11. However, air traffic is expected to grow in the near future. One important issue linked to growth is the location and the size of airports. Wherever an airport is located, residents nearby will be disturbed, and whenever an airport expands, the disturbance and the number of people disturbed will increase. How residents perceive disturbance from air traffic, and the welfare losses linked to this, is therefore an important issue for decisions regarding both the location and the size of airports. Furthermore, the aviation sector is currently moving away from a command-and-control type of environmental regulation with engine standards and a phasing out of engine types towards implementation of incentive-based pricing systems (see e.g. Carlsson, 2003; Morrell and Lu, 2001). This is in line with the European Union recommendation of increased use of incentive-based pricing in the transport sector (European Union, 2001).

A successful environmental regulation of externalities requires information about the marginal damage. In this paper we focus on noise damages from air traffic. Noise externalities are rather different from other types of externalities caused by air traffic since the marginal damage can vary with the time of the day and the day of the week, which is completely different from externalities caused by e.g. air pollution. For example, the external damage of one night-flight is presumably more damaging than the same flight made during the day. There are also findings that for example suggest that noise from air traffic is considered to be more disturbing than the equivalent noise disturbance (i.e. the same noise disturbance in terms of decibel) from road traffic (Naturvårdsverket, 2001).

There are surprisingly few studies on the aggregated marginal damage from air traffic noise. The majority of these studies have applied a hedonic pricing approach, and as will be discussed in the next section, there are some important shortcomings associated with hedonic pricing studies. The two main problems are that (1) it is difficult to estimate welfare measures from hedonic studies, and (2) it is almost impossible to estimate welfare measures for changes in noise from air traffic at different days of the week, as well as at different times of the day. An alternative is to use a stated preference method approach, such as a contingent valuation survey or a choice experiment.

In this paper we employ a choice experiment to estimate the welfare effects via changes in the number of take-offs and landings at a city-center airport in Stockholm, Sweden.[1] In a choice experiment, respondents are presented with a hypothetical situation, in our case that the number of landings and take-offs at Bromma Airport will either increase or decrease depending on the survey version assigned to them. The respondents are then asked to choose the preferred alternative among several alternatives in each choice set presented, and normally they are asked to perform a sequence of choices containing 5-15 choice sets. In the case of an increase they would be compensated, while for a decrease there would be an extra payment. In our experiment the attributes relate to the number of take-offs and landings in one hour at different times of the day. Moreover, half of the choice sets concern the stated situation during working days and half during weekends. The strength of a stated preference method is that we can estimate the welfare changes for changes in the number of take-offs and landings at levels which do not exist today. It also provides us with easily interpretable results. The rest of the paper is organized as follows. In Section 2 we discuss previous studies on airport noise followed by a section where we explicitly discuss the situation at Bromma Airport. In Section 4 we present the design of our choice experiment, followed by the results in Section 5. Finally, Section 6 concludes the paper.

2. Previous studies of airport noise

There are a number of studies assessing the value of aircraft noise nuisances. A majority of these studies are hedonic price studies (e.g. Nelson, 1980; Levesque, 1994; Uyeno et al., 1993; Pennington et al., 1990); but there are also studies using the contingent valuation method (Feitelson et al., 1996) and similar stated preference methods (van Praag and Baarsma, 2000). Most of the hedonic pricing studies find a noise depreciation index of around 0.5-0.7, i.e. if the noise nuisance increases by, say, 10 units, then property prices decrease by 5-7%. A summary report, based on over 20 studies using the hedonic pricing method, finds little or no disturbance up to the level of 60-65 dB CNEL,[2] while people are highly annoyed above a noise level of 75dB CNEL (Orange County Business Council, 2000). However, welfare measurement is

[1] See for example Alpizar et al. (2003) and Louviere et al. (2000) for overviews of choice experiments.
[2] CNEL, Community Noise Equivalent Level, is a calculated average noise level measured in decibel.

somewhat complicated in hedonic studies, at least if one wants to obtain generic values of attributes (Haab and McConnell, 2002). It is also difficult, if not impossible, to disentangle the external damages related to different points in time. It is very likely that the marginal external damage of noise varies by the time of day and by the day of the week. An alternative approach would be to use a stated preference survey to assess the value of noise nuisances, especially since the marginal values most likely vary by the day of the week and by the time of the day. Both Feitelsson et al. (1996) and Barreiro et al. (2001) use the contingent valuation method to measure the willingness to pay for reducing noise from air traffic. Feitelsson et al. actually use a number of scenarios in order to evaluate how willingness to pay varies with various attributes such as the frequency of noise and the noise from overhead flights. They find that their estimates of the costs of noise are higher than the comparable costs found in hedonic pricing studies. They also find a kinked WTP function, where respondents are not at all willing to consider living in a house above a certain noise level. Barreiro et al. (2001) find that households in Pamplona in Spain are on average willing to pay 4 Euros per year to reduce the general noise level by one decibel.

3. Description of Bromma Airport

Our study is conducted in Stockholm, Sweden, where two airports are situated: Arlanda Airport and Bromma Airport. Arlanda is Stockholm's main domestic and international airport and the largest in Sweden in terms of the number of flight movements. Bromma is Sweden's third largest airport in terms of the number of flight movements and the second largest for domestic flights. Bromma Airport is located only 8 kilometers from the city center of Stockholm, while Arlanda Airport is located 45 kilometers away from the city center. Thus, take-offs and landings from Bromma Airport occur above areas with high population densities. The present environmental regulations for Bromma Airport are stricter than those for Arlanda (Luftfartsverket, 2002). In comparison to Arlanda, aircraft operations at Bromma Airport are completely banned during the night hours; operations are allowed only 7am - 10pm on weekdays, 9am - 5pm on Saturdays and 10am - 8pm on Sundays. There is an upper limit on aircraft noise levels set to 89 EPN decibels.[3] There is also a maximal weight

[3] EPNL, Effective Perceived Noise Level, is a value of certification for every type of aircraft when they take off or land.

limit for an aircraft set at 50,000 kg, and the total number of take-offs and landings per year are restricted to 65,000.

Both the existence and the size of Bromma Airport have been frequently debated over the last decades due to its location close to the city center of Stockholm. Different political parties have had varying opinions about what the right size of the airport should be, and within some of the parties the views have changed over time. The current regulations and volume of air traffic at Bromma Airport are an outcome of a political process, which has evolved over many years. The latest agreement between the City Council, which is the supreme decision making body of the City of Stockholm, and the Swedish Civil Aviation Administration states that Bromma Airport will be shut down by the end of 2011 (Luftfartsverket, 2003). If Bromma Airport is shut down it has to be replaced by a new airport, preferably located not far from the city center of Stockholm. The present political majority of the City Council wants to use the area to build a new residential area after the airport has been shut down. Building a new residential area will, however, result in other effects on the current residents such as increased road traffic and possibly changes in housing prices. On the other hand, some of the political parties currently in opposition do not want the airport closed by 2011. The future of the airport is a widely debated topic and people living close to the airport often have, for natural reasons, strong opinions about the existence of the airport. This has been shown in previous attitudinal studies on the airport (see e.g. Blomqvist et al., 2000).

Kriström (1997) reports the results from a contingent valuation study on the size of Bromma Airport in 1993. The paper has a strong bearing on methodological development since the spike models are introduced. This type of model essentially allows a proportion of the respondents to have a zero willingness to pay in a closed-ended contingent valuation survey, which is not the case when using ordinary parametric models such as a probit model. Briefly, the changes in the size of the airport were described as follows: (i) an expansion of the airport would be beneficial to local business and (ii) a decrease would yield environmental benefits. Interestingly, the construction of the survey allowed Kriström to discover that slightly more than 70% are indifferent between an increase and a decrease in the size of the airport. Kriström reports these individuals as having a zero willingness to pay for a change and thus these respondents do not see the Bromma airport as a major environmental problem.

4. Design of the choice experiment

There are small differences in noise levels among the different types of aircrafts using Bromma Airport (Luftfartsverket, 2002).[4] It is however likely that the marginal damage caused by take-offs and landings at the airport varies with the time of the day and with the day of the week. Therefore we specify the flight movements in the choice experiment to be the number of take-offs and landings at different times of the day (early mornings, mornings, afternoons and evenings) and on different days of the week (weekdays and weekends). Furthermore, since there has been a discussion on both an increase and a decrease in the size of the airport, we designed two separate versions of the choice experiment: one describing an increase in the number of take-offs and landings and another describing a decreased number of take-offs and landings. Before the main study was conducted, a focus group study and two pilot studies were undertaken. At each stage we made changes both in the scenario as well as in the levels of attributes used in the choice experiment.[5]

A change in the number of take-offs and landings of course have effects other than on the perceived noise level per se, e.g. it changes the risk of accidents and the level of air pollution. These effects were mentioned in the scenario, but it was stated that these changes would be small and should be neglected when responding to the choice experiment. Thus, our aim is to isolate the welfare effect of changes in noise due to an increase and to a decrease in the number of flight movements in our choice experiment. The complete scenario is presented in the Appendix. The respondents were informed of the number of present flight movements at the Bromma Airport. These are reported in Table 1.

Table 1. The present number of flight movements at Bromma Airport during an average day in May 2003.

	Weekdays Monday-Friday	Weekends Saturday and Sunday
Early morning 7 am – 9 am	16 per hour	0 per hour
Morning 9 am – 12 noon	10 per hour	7 per hour
Afternoon 12 noon – 5 pm	11 per hour	8 per hour
Evening 5 pm – 10 pm	12 per hour	14 per hour

[4] The different types of aircrafts operating at Bromma Airport have a maximum noise level between 78 and 83 dB (A) when landing. The maximum noise level is between 75 and 83 dB (A) when taking off.

[5] In the pilot studies the sample sizes were 240 and 96 respectively.

Sources: Timetables from airlines operating at the airport, and statistics from the Swedish Civil Aviation Administration.

In the choice experiment we separate weekdays from weekends, and each respondent answered three choice sets for weekdays and three choice sets for weekends. The attributes and levels used in the choice experiment are presented in Table 2, where the exchange rate at the time of the survey was 1 USD=8 Swedish kronor (SEK). Moreover, as mentioned before, there were two different versions of the choice experiment including either a decrease in the number of take-offs and landings or an increase. However, each respondent was assigned only to one of these two versions.

Table 2. Attributes and levels used in the choice experiment.

Attributes		**Levels**	
		Decrease in the number of flight movements	Increase in the number of flight movements
Weekdays	Early morning 7 am – 9 am	3, 6, 12, 16	16, 20, 24, 30
	Morning 9 am – 12 noon	5, 10	10, 16
	Afternoon 12 noon – 5 pm	5, 11	11, 16
	Evening 5 pm – 10 pm	0, 6, 12	12, 18, 24
	Payment/compensation in SEK	10, 25, 50, 75, 125	10, 25, 50, 75, 125
Weekends	Morning 9 am – 12 noon	0, 3, 7	7, 10, 15
	Afternoon 12 noon – 5 pm	4, 8	8, 12
	Evening 5 pm – 10 pm	0, 7, 14	14, 21, 28
	Payment/compensation in SEK	10, 25, 50, 75, 125	10, 25, 50, 75, 125

One important issue when considering changes is whether or not to include an opt-out alternative in the choice sets, where the opt-out alternative represents the current situation. The decision of whether or not to include an opt-out alternative depends partly on how the results from the choice experiment will be used. If the main purpose of the choice experiment is to estimate the marginal rate of substitution between attributes given that a change will take place, then an opt-out alternative should not be included. On the other hand, if one question to be answered by the research is if the size of the airport should change at all, then it would be preferable to include an opt-out alternative. There are also other aspects that may affect whether or not an opt-out should be included. For example, inclusion of an opt-out alternative may result in respondents choosing the opt-out alternative as a convenient way of responding, which could be seen as status quo bias. On the other hand, not including an opt-out alternative could make the respondents feel that they are put in an awkward position since they are forced to make a choice between two alternatives, both representing a change. In our case it was not clear from a policy perspective if an opt-out alternative should be included or not. As discussed above, previous studies on opinions about the future of the airport have found that individuals may have rather strong opinions on the size of the airport. Based both on Kriström (1997) and the results from our pilot studies, there seems to be a significant proportion of people not wanting any changes. Thus, exclusion of an opt-out alternative would then potentially result in an econometric analysis based on data where individuals in one way or another try to seek a strategy to choose the alternative they consider to be closest to the current situation, resulting in sensitive estimates. Thus, we include an opt-out alternative in each choice set in both the increase and decrease version of the choice experiment. However, we also wanted to test if there would be any differences if the opt-out alternative were excluded in the choice set, but we only test for this in the increase version.

The choice sets were constructed by using the D-optimal design routine in SAS (Kuhfeld, 2001). We created 15 choice sets for the increase and the decrease versions as well as for weekdays and weekends separately, and these were then blocked into five groups. We used the same alternatives in both of the increase versions, with the only difference being that we included an opt-out alternative in the opt-out versions. It should be noted that the monetary description used in the increase version is compensation, while in the decrease version it is a payment. An example of a choice set for the survey version with a decrease in the number of flight movements is presented in Figure 1.

Figure 1. Example of a choice situation.

	Alternative 1	*Alternative 2*	*Alternative 3*
Early morning 7 am – 9 am	16 per hour	12 per hour	3 per hour
Morning 9 am – 12 noon	10 per hour	10 per hour	5 per hour
Afternoon 12 noon – 5 pm	11 per hour	11 per hour	5 per hour
Evening 5 pm – 10 pm	12 per hour	6 per hour	0 per hour
Your payment per month for a reduction in noise (per year)	0 SEK (0 SEK)	50 SEK (600 SEK)	75 SEK (900 SEK)
Your choice			

The responses obtained from the choice experiment are discrete choice responses. In the analysis of the responses we apply a general type of model, namely a random parameter model. In such a model, taste variation among individuals is treated explicitly (see e.g. Train 1998). Let us define a latent utility function of alternative *i* for individual *q*, at choice situation *t*, consisting of a systematic and a stochastic part:

$$U_{iqt} = \alpha_{iq} + \gamma_i s_q + \beta_q x_{iqt} + \varepsilon_{iqt},$$

where s_q is a vector of socio-economic characteristics and x_{iq} is a vector of attributes. The alternative specific intercept, α_{iq}, captures an intrinsic preference for the alternative and γ_i captures systematic preference heterogeneity as a function of individual characteristics. The coefficient vector β_q varies among the population with density $f(\beta \mid \theta)$, where θ is a vector of the true parameters of the taste distribution. If the error terms, $\varepsilon's$, are IID type I extreme values, we have a random parameter logit, or a mixed logit, model (Train, 1998; 2003). It is necessary to make an assumption regarding the distribution of each of the random coefficients. In principle any distribution could be applied. Here we will, mainly for simplicity, assume that all attributes of the choice experiment are normally distributed with the exception of the cost attribute, which is assumed to be fixed. Of special interest here is to estimate the marginal willingness to pay for take-offs and landings at various times of the day and of the week. Since we have assumed a utility function that is linear in the attributes including the payment/compensation attribute, the marginal willingness to pay for a decrease in the number of take-offs and landings at a certain time is simply the ratio between the parameter of the corresponding attribute and the parameter of the payment/compensation attribute, see e.g. Hanemann (1984). Furthermore, due to our assumptions about the utility function, marginal willingness to pay and marginal willingness to accept compensation will be the same. It is therefore possible to directly compare the estimates from the different versions of the choice experiments.

5. Results

The survey was sent out in 2003 to a random sample of individuals in the 18-64 age group living in the Bromma district of Stockholm. After deducting the number of questionnaires returned because the addresses had moved there were 1558 questionnaires sent out. People living in this district are those most affected by the noise from Bromma Airport. In addition to the choice experiment, the survey also included questions on socio-economic characteristics as well as attitudinal questions regarding Bromma Airport. The overall response rate to the survey was 46%, which is in line with similar studies in Sweden.

In order to allow for observed preference heterogeneity in the econometric model, we include as explanatory variables the gender of the respondent, the frequency of someone the respondent household using Bromma Airport and whether the respondent lives in a house. These socio-economic characteristics are assumed to affect whether the respondent will prefer the opt-out alternative or not. This also means that in the third model, i.e. in the binary choice model without opt-out, these socio-economic characteristics are not included. It is possible to divide the households into two groups depending on the level of noise from air traffic in the area where they live. The so-called noise zone includes households that have an average noise level from air traffic above FBN[6] 55 dB (A). The residential areas identified as being inside the noise zone were Bromma Kyrka, Bällsta and Ulvsunda Industriområde (Luftfartsverket, 2002). Descriptive statistics for these socio-economic variables, based on the two survey versions with opt-out alternatives, are presented in Table 3.

Table 3. Descriptive statistics

Variable	Description	Mean	Stdv
Do not use Bromma	= 1 if respondent does not fly from Bromma	0.471	0.499
Fly often from Bromma	= 1 if respondent flies often from Bromma	0.053	0.224
Female	= 1 if respondent is a female	0.544	0.499
Detached house	= 1 if respondent lives in a detached house	0.453	0.498
Zone	= 1 if respondent lives inside the noise zone	0.122	0.327

Another important issue that affects the answers is whether or not any household member is at home at the different times of the day specified in the choice set. Since there are reasons to believe that respondents do not care about the number of take-offs and landings at times when nobody is at home, they will not consider those attributes when answering the questions in the choice experiment. Therefore we set the number of movements to zero for those attributes, i.e. time of day when no one in the household is at home.

[6] FBN is the average logarithmic sound level and it considers at what times of the day the aircrafts pass by a measurement point, e.g. one flight movement in the evening is considered to be three times as disturbing as a daytime flight.

In Table 4, we present the results from the estimations. We did not find any significant differences in willingness to pay between respondents living inside the noise zone and outside this zone. Therefore we only report the estimates without the noise zones. In columns three and four, the results of the choice experiments without an opt-out alternative are presented, while we in columns five to eight present the results of the mixed logit model for decreases and increases in the number of take-offs and landings with an opt-out alternative. In all models we assume that the utility function is linear in the attributes, which also includes the payment/compensation attribute.

Table 4. Estimated models for the three choice experiments

Attributes		Whole sample						Restricted sample			
		Increase no opt-out		*Increase opt-out*		*Decrease opt-out*		*Increase opt-out*		*Decrease opt-out*	
Random parameters		Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value	Coeff	P-value
Departures weekday	7 am-9 am	-0.0807	0.005	-0.1014	0.001	-0.1410	0.005	-0.1249	0.000	-0.2192	0.000
	9 am-12 noon	-0.0239	0.599	0.0327	0.477	-0.4813	0.004	0.0694	0.221	-0.7248	0.003
	12 noon-5 pm	-0.0044	0.918	0.0537	0.252	0.1970	0.113	0.0684	0.206	0.2074	0.079
	5 pm-10 pm	-0.2107	0.000	-0.1386	0.000	-0.1573	0.000	-0.1420	0.000	-0.1972	0.000
Departures weekend	9 am-12 noon	0.0607	0.009	-0.1959	0.000	-0.1099	0.057	-0.2043	0.000	-0.1330	0.071
	12 noon-5 pm	-0.1989	0.000	-0.0529	0.401	-0.0825	0.320	-0.0669	0.337	-0.0078	0.951
	5 pm-10 pm	-0.0956	0.000	-0.2459	0.000	-0.1651	0.000	-0.2582	0.000	-0.3440	0.001
Intercept: Today's level				-2.4726	0.000	20.8219	0.000	-2.5443	0.000	-1.5805	0.186
Standard deviations											
Departures weekday	7 am-9 am	0.2253	0.000	0.1541	0.000	0.2127	0.003	0.2022	0.000	0.4748	0.000
	9 am-12 noon	0.1983	0.016	0.0123	0.882	0.1668	0.610	0.0934	0.278	0.3792	0.047
	12 noon-5 pm	0.0731	0.465	0.0205	0.773	0.3398	0.009	0.0932	0.283	0.6742	0.001
	5 pm-10 pm	0.2327	0.000	0.1336	0.002	0.1912	0.000	0.1767	0.000	0.1271	0.025
Departures weekend	9 am-12 noon	0.0131	0.790	0.2860	0.000	0.1164	0.203	0.2974	0.000	0.0460	0.856
	12 noon-5 pm	0.2793	0.000	0.1584	0.108	0.0363	0.807	0.2434	0.040	0.4516	0.109
	5 pm-10 pm	0.1031	0.001	0.2535	0.000	0.1731	0.007	0.3462	0.000	0.3395	0.001
Intercept: Today's level				6.7466	0.000	15.9286	0.000	2.7729	0.000	2.7692	0.000
Fixed parameters											
Payment/Compensation		-0.0067	0.0145	0.0097	0.000	-0.0264	0.000	0.0098	0.000	-0.0354	0.000
Do not use Bromma				2.8458	0.000	-9.9466	0.000	0.6034	0.345	-0.1287	0.875
Fly often from Bromma				-1.3969	0.254	-7.7876	0.000	-0.8916	0.538	0.2694	0.886
Female				2.4363	0.001	-3.5544	0.010	0.6223	0.277	-2.1001	0.022
Detached house				2.1545	0.001	2.0262	0.143	-0.5131	0.489	1.4919	0.143
Share of responses											
1 (today's level)					59%		81%		27%		26%
2			59%		22%		11%		40%		42%
3			41%		19%		8%		33%		32%

Most standard deviations of the random parameters are significant and the mixed logit models have a substantially higher pseudo-R^2 compared with the corresponding nested logit model (not reported here). Among the socio-economic characteristics, we find that if no one from a household flies from the Bromma airport then the respondent is more likely to choose the opt-out alternative in the version with increased numbers of take-offs and landings, and significantly less likely to choose opt-out in the decrease version. The same effect is present for female respondents. Surprisingly, respondents from households where at least one household member often flies from Bromma are less likely to choose the opt-out alternative in the decrease survey versions. Those living in detached houses are significantly more likely to choose the current situation, which might be a sign of being afraid of changes since this may, in an unknown way, affect the property values. The monetary attribute is, as expected, significant and negative in the decrease version, i.e. the higher the payment *ceteris paribus* the more likely a respondent is to opt-out, and the increase version with compensation has the opposite effect.

In the binary model, the parameter of the monetary attribute, i.e. compensation, is highly insignificant. In the versions including opt-out alternatives, i.e. the current situation, the monetary attributes are significant and of the expected sign. It seems that excluding the opt-out alternative in the binary experiment has resulted in the respondents have not having considered the cost attribute when making their choices, and rather having adopted some other simplified decision strategy. This is supported in the survey versions with an opt-out alternative in the choice set since many respondents always chose the opt-out alternative. In the increase survey version, 45 % of the respondents always choose the current situation, while in the decrease survey version the share of non-traders was as high as 75 %. These levels seem to be slightly lower than the shares of non-traders found in the contingent valuation survey by Kriström (1997), since for example some of the non-traders in the increase version might be traders in the decrease version and vice versa. Consequently, a large share of the respondents do not seem to want a change in the number of take-offs and landings at Bromma Airport. Although these respondents should not affect the estimates of the marginal willingness to pay since the responses should only affect the alternative-specific intercept, we re-estimate both models after exclusion of these non-traders. The estimates from these sub-samples are presented in columns 9-12 in Table 4. Since we cannot compare the size of the coefficients across the estimated models, it is better to compare the results by looking at the estimated marginal willingness to pay. Since the parameter of the monetary attribute was not significant in the survey version without the opt-out alternative, we do not calculate the marginal willingness to pay for this version. The results are presented in Table 5, where the standard errors are estimated using the delta method (Greene, 2003).

Table 5. 95% confidence interval of the estimated marginal willingness to pay in SEK per month for a decrease in the number of take-offs and landings (in parentheses the point estimate).

	Departures Weekdays			
	Decrease with opt-out		Increase with opt-out	
	Whole sample	Restricted sample	Whole sample	Restricted sample
Early morning 7 am – 9 am	2.21 – 8.47 (5.34)	3.17 – 9.22 (6.20)	4.62 – 16.18 (10.40)	5.55 – 19.84 (12.70)
Morning 9 am – 12 noon	7.85 – 28.60 (18.22)	10.43 – 30.53 (20.48)	-11.11 – 4.44 (-3.35)	-16.73 – 2.60 (-7.06)
Afternoon 12 noon – 5 pm	-15.12 – 0.20 (-7.45)	-11.44 – -0.287 (-5.86)	-13.65 – 2.64 (-5.51)	-16.32 – 2.43 (-6.95)
Evening 5 pm – 10 pm	3.15 – 8.86 (5.96)	3.26 – 7.89 (5.57)	8.48 – 19.96 (14.22)	8.46 – 20.42 (14.44)
	Departures Weekends			
	Decrease with opt-out		Increase with opt-out	
	Whole sample	Restricted sample	Whole sample	Restricted sample
Morning 9 am – 12 noon	0.52 – 7.81 (4.16)	0.24 – 7.27 (3.76)	10.27 – 29.93 (20.10)	10.37 – 31.17 (20.77)
Afternoon 12 noon – 5 pm	-2.08 – 8.33 (3.12)	-5.66 – 6.10 (0.22)	-5.32 – 16.18 (5.43)	-4.94 – 18.54 (6.80)
Evening 5 pm – 10 pm	3.82 – 8.68 (6.25)	5.85 – 13.59 (9.72)	14.81 – 35.66 (25.24)	14.69 – 37.84 (26.26)

As can be seen in Table 5, there are no significant differences between the estimates based on the whole sample and the restricted sample, which excludes non-traders. It should be noted that exclusion of non-traders results in the welfare effects being expressed for a sub-sample, and these values have to be adjusted if we want to obtain values for the whole population. In turn this implies that one cannot use these estimates directly for a welfare evaluation since the marginal willingness-to-pay is zero, or even negative, for some respondents. In general the estimated marginal willingness to pay is higher for the increase version with one exception: departures in the morning during weekdays. It is difficult to know why this time of the day would be the exception. The major disturbances according to our estimates are during the mornings and the evenings both for weekdays and weekends. If we focus on the increase survey version, the marginal willingness to pay is about 10 SEK per month for take-offs or landings in the early mornings during weekdays and about 20 SEK in the mornings during weekends. Moreover, the willingness to pay is even higher in the evenings.

6. Discussions and conclusions

This paper provides some empirical evidence about the marginal willingness to pay for changes in noise from air traffic related to increases and decreases in the number of take-offs or landings at Bromma Airport, located close to the city center of Stockholm. By using a choice experiment, we can estimate the marginal willingness to pay both at different times of the day and by using two sections in the choice experiment also on different days of the week.

In two out of our three choice experiment versions, we added an opt-out alternative to the other two alternatives in each choice set. A substantial proportion of our surveyed individuals did prefer the current situation, i.e. they chose the current situation in all choice sets, both in the increase (45%) and in the decrease (75%) versions. These figures do not come as a surprise given that Kriström (1997) found that more than 70% were non-traders in his contingent valuation survey. Moreover, this manifests itself since the version without an opt-out alternative did not result in significant estimates of the monetary attribute. In our case the proportion of non-traders is lower despite the fact that we in each version only explore trading in one direction, either as an increase or a decrease in the number of take-offs and landings. A generally high proportion of non-traders may also indicate that other, non-standard economic aspects are important to consider. There is a general tendency for a higher proportion of non-traders in the decrease version as well as a generally lower marginal willingness to pay in the decrease version. This result would be in line with the evidence suggesting divergence between willingness to pay and willingness to accept, which is particularly large for non-market goods (e.g. overview in Horowitz and McConnell, 2002). One explanation is the endowment effect whereby respondents are reluctant to pay money for an improvement; see e.g. Kahneman et al, 1990. Moreover, as argued in Kahneman et al. (1999), responses in surveys are more likely to be expressive than to represent a value. In addition to the psychological explanations, we should be aware that the current size of Bromma Airport, established in 1936, is a result of political debates, and hence the individuals have at least indirectly affected the current size of the airport.

As we have discussed, our experience is that a large proportion of people involved are satisfied with the current level of flight operations at Bromma Airport and hence they are not prepared to trade off an increase or a decrease for a monetary compensation or payment. It should be noted that there are restrictions both on aircraft noise levels and the weights of the aircrafts allowed to take off and land at Bromma Airport. Thus, it is relatively speaking a silent airport despite its size. However, as elicited in surveys on self-assessed disturbance of noise, both timing of the day and mode of transport matters, where air traffic is considered to be worse than road and train traffic. Thus, it is important to estimate marginal willingness to pay directly related to air traffic. As far as we are aware, these are the first estimates of marginal WTP separated on the day of the week and the time of the day. The estimates indicate that some of the residents in the Bromma area have a sizeable willingness to pay for a decrease in the number of take-offs or landings on mornings and evenings during both weekdays and weekends. The marginal values are in the range of 4.16 SEK to 18.22 SEK (0.52-2.28 USD) when using the point estimates per hourly take-off or landing during these hours. At the same time a large share of the respondents are not willing to pay anything at all for a change in the number of departures. Moreover, our choice experiment has shown that it is important to understand the underlying opinions regarding the changes being analyzed.

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Appendix. Instructions to the respondents

In this part of the survey we assume that Bromma Airport will not be shut down in the foreseeable future. Flights to and from Bromma airport result in noise, and a number of measures can affect this. The measures we are interested in are the number of take-offs and landings at various times. By increasing the number of take-offs and landings the noise in the area you live in will increase. An increase in take-offs and landings can also result in an increased risk of accidents and increased emissions, even if these effects are small. In this part of the study we are only concerned with aircraft noise. *We therefore ask you to only consider aircraft noise when answering the questions.*

An increase in aircraft noise can be a nuisance to your household. We are therefore interested in knowing how much your household would require in compensation for this. We ask you to imagine that when the noise increases your household will receive an amount of money per month. These monies will be paid by the Bromma airport, which will increase their revenues from the increased air traffic. This means that you every month will have more money to spend.

You will make six different choices. The first three ones concern air traffic during weekdays and the last three concern air traffic during weekends. We ask you to mark the alternative your household prefers in each of the six cases. When choosing you should weigh the compensation against the increase in noise that occurs when the number of take-offs and landings increases. The composition of small and large aircrafts and the types of aircrafts will be the same as today.

The present situation at Bromma Airport is summarized below. This is for an ordinary day in May.

Average number of take-offs and landings per hour

Weekdays		*Weekends*	
Early morning 7 am – 9 am	16 per hour	Early morning 7am – 9am	0 per hour
Morning 9 am – 12 noon	10 per hour	Morning 9am – 12noon	7 per hour
Afternoon 12 noon – 5 pm	11 per hour	Afternoon 12noon – 5pm	8 per hour
Evening 5 pm –10 pm	12 per hour	Evening 5pm –10pm	14 per hour

Below is an example of a choice situation. As you can see you are supposed to compare the present situation with other possible alternatives.

Example Weekdays

	Alternative 1	*Alternative 2*	*Alternative 3*
Early morning 7 am – 9 am	16 per hour	24 per hour	16 per hour
Morning 9 am – 12 noon	10 per hour	10 per hour	11 per hour
Afternoon 12 noon – 5 pm	11 per hour	16 per hour	16 per hour
Evening 5 pm – 10 pm	12 per hour	12 per hour	12 per hour
You compensation for increased noise (per year)	0 SEK (0 SEK)	75 SEK (900 SEK)	50 SEK (600 SEK)
Your Choice		X	

> In this case I have chosen Alternative 2 which has more take-offs and landings per hour in the early morning and in the afternoon compared with Alternative 1, and hence more noise. My choice means that my household receives a compensation of 75 SEK per month, i.e. 900 SEK per year. I also think that Alternative 2 is better than Alternative 3.

We want you to only consider aircraft noise and your compensation.

Note: We are not investigating whether you think that Bromma airport should be shut down or not.