

February 20, 2009

**Fly or Cry:
Is Airport Noise Costly?***

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Abstract

This paper examines new evidence on the costs of airport-related noise (and other disamenities of airports) for individuals. In contrast to previous work which has mainly focused on property prices to document the costs of airport noise, I analyze voting results from a recent city-wide ballot poll on airport closure; direct voting should provide useful insights on the overall assessment of the costs and benefits of an airport by residents. Using data from a referendum on the closure of one of Berlin's inner-city airports, Tempelhof, I find that voting behavior is neither affected by airport distance nor by airport-related noise exposure. In contrast, strong opposition to closure in the vicinity of Tempelhof indicates that adaptive preferences may be important.

JEL Code: D61, D62, H41, I18, R41

Keywords: noise; preferences; traffic; airports

* I thank Nicolai Wendland for exceptional research assistance.

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1. Introduction

On 30 October 2008, the Berlin city government closed all operations on Tempelhof airport (IATA code THF), one of the city's three commercial airports. The closure is part of a plan to concentrate all passenger flight activities in the region at a single location, Schönefeld airport (SXF), where currently new runways and terminal buildings are being built. When the expansion of Schönefeld is completed, the new airport (called "Berlin Brandenburg International") is expected to also replace the city's current main airport, Berlin-Tegel (TXF).

The closure of Tempelhof airport was heavily disputed in public. For one thing, the airport has a long and rich history. The area has been used as an airfield since 1909 when first flight demonstrations were made by, among others, Orville Wright. With the growing emergence of air passenger traffic, Tempelhof became officially designated as an airport in 1923, making it one of the oldest commercial airports in the world. Tempelhof has also been temporarily one of the world's busiest airports. In 1926, the German national airline, Lufthansa, was founded in Tempelhof. During the 1930s, the airport handled more than 30 percent of German air passenger traffic. After the end of World War II, the importance of Tempelhof declined. Hub travel (and Lufthansa) relocated to West Germany; city-related air traffic increasingly shifted to Tegel which became Berlin's major airport in the mid-1970s. Despite its decreasing role as flight destination, however, Tempelhof remained of large symbolic value. When, shortly after the division of Berlin among the victorious powers, Soviet authorities blocked all water- and land-borne transportation into and out of the three western-controlled sectors of Berlin, western allies supplied the population by air. Since Tempelhof was central to the Berlin Airlift operation, with more than 275,000 flights from June 1948 to May 1949, the airport became a forceful symbol for freedom for the rest of the cold war period.

Another reason for opposition to closure is the convenient geographic location of the airport. Tempelhof is situated close to the city center; the airport is well integrated into the city's public transport system. While the location in the inner-city area limits the capacity of the airport, it appears to offer good opportunities for short-distance flights or business travel.

In view of these arguments and a controversial public discussion, interest groups initiated a city-wide referendum ("Volksbegehren") on the closure of Tempelhof airport. Having a direct vote of the electorate on a specific issue (as well as the necessary preconditions for such a referendum) is defined in the constitution of Berlin; a ballot poll has been used for the first time in the political history of the state of Berlin. The referendum was held on 27 April 2008. In total, 881,035 votes were cast, of which the majority (529,880 or

60%) were indeed in favour of keeping the airport open. Still, the referendum failed. Since voter turnout was low (about 36%), the votes for the initiative were only 21% of the total electorate of about 2.438 million eligible voters, while a quorum of 25% had been required.

Given that the referendum was designed as a simple yes-or-no vote on a single question, the closure of Tempelhof airport, the results of the referendum provide a natural experiment to analyze the value of intangibles. Any airport location is typically associated with benefits and costs. Amenities of airports include, among others, access to flight travel and good shopping and employment opportunities. Disamenities include, most notably, aircraft noise but also, for instance, the risk of plane crashes. Previous research (as well as frequent opposition to airport expansion) suggests that, for locations adjacent to airports, the costs outweigh the benefits. For instance, it has been widely documented that land values tend to decline as airport noise increases; see Nelson (2004) for a meta-analysis. Van Praag and Baarsma (2005) find that life satisfaction is lower for higher values of the respondent's subjective noise perception. In this paper, I provide a novel approach to analyze the net value of airports, based on direct voting behaviour. More specifically, I argue that in districts close to Tempelhof airport (or, more precisely, given tightly defined flight corridors for take-off and landing, in districts that are particularly exposed to aircraft noise), the preference for closure of Tempelhof airport should have been particularly strong. To preview the main results, I find that neither voter turnout nor voting results of the referendum is associated with airport noise levels.

The remainder of the paper is organized as follows. Section 2 briefly reviews the existing literature on the costs of airport noise. Section 3 provides some additional background on the Tempelhof referendum, followed by a detailed description of the data and the empirical methodology. Section 5 contains the key findings of the paper, presenting the empirical results. Section 6 briefly concludes.

2. Literature Review

The costs of airport noise are the subject of a large and extensive literature. Building on the insights of Pigou (1920) and Coase (1960) on the difference between social and private costs, these papers generally aim to quantify the total costs that airport location puts on society. However, since the value of intangibles, such as the pleasure of peacefulness and quietness, for individuals is often not directly observable, various indirect methods are applied.

The most prominent approach to price the amenities and disamenities of airports is to examine the effects of airport location on the value of relevant market-priced goods, such as

housing and residential property. These studies typically estimate hedonic price functions in which differences in house prices are explained by various structural characteristics (such as house size) and locational attributes (e.g., crime rates). Including an additional control variable on noise levels then allows quantifying the discount that is associated with noise exposure. Standard results suggest that ...; Nelson (2004) provides a recent meta-analysis of 20 studies (and 33 estimates) on North American airports.

Still, despite its intuitive design, the price-based approach is not without difficulties. For one thing, the estimation of hedonic price functions may be flawed. Zoning and other forms of regulation may distort prices; also, aiming to control for all kinds of house price attributes runs the risk of omitted variable bias. More importantly, it is questionable to what extent prices do indeed measure social costs. On the one hand, house prices reflect the preferences of the marginal buyer, not society in general. On the other hand, lower house prices may provide full compensation for locational disamenities, allowing buyers, for instance, to afford larger homes. As a result, spatial sorting of home owners (depending on individual preferences) may ensure that the aggregate net value of intangibles is at least zero or perhaps even positive.

An interesting approach to deal with this last issue and to identify the total effect of airport location on an individual's well-being is provided in Van Praag and Baarsma (2005). They perform an extensive survey among households living close to Amsterdam's Schiphol airport, asking, among other things, about their personal 'quality of life'. Interestingly, Van Praag and Baarsma (2005) find no association between life satisfaction and measured noise levels at the household's living place, after holding constant for other determinants of happiness. It is only when life satisfaction is compared with the respondent's perceived exposure to aircraft noise that a statistically significant negative relationship becomes detectable. This finding, however, may suffer from endogeneity. Respondents that have the subjective feeling that they are particularly exposed to noise (though, in practice, they are not) may also be more dissatisfied with their lives more generally. Another potential problem is the small sample size with a questionnaire response rate of only 17%, producing in total 1400 observations.

A third approach to quantify the value of intangibles is to ask about the households' willingness to pay for environmental goods (or, alternatively, their willingness to accept compensation for a deterioration in their environment). This contingent valuation approach has been applied in the context of airport noise in Feitelson, Hurd and Mudge (1996) and Carlsson, Lampi and Martinsson (2000), among others. Although perhaps insightful, the main

shortcoming of such surveys based on hypothetical questions is that respondents have little or no incentive to reveal their true valuation. Rather, they are likely to respond strategically; that is, they tend to inflate or deflate prices in order to influence the overall result according to their preferences. As a result, answers should be assessed with caution.

The natural experiment that is described and analyzed in this paper allows dealing with many of these problems in the existing literature. Direct voting on airport closure provides the ultimate feedback on an eligible voters overall assessment of the costs and benefits of airport location. Also, the number of respondents is reasonably large. Finally, the risk of strategic voting behaviour appears to be limited because the outcome of the referendum could have led to real world consequences; although the results of the referendum are de jure non-binding for the Berlin city government, it is widely agreed that a majority vote in favour of continued operation of Tempelhof airport would have de facto exerted strong pressure on the city government to rethink their decision.

3. The 2008 Referendum on Tempelhof Airport

According to the Berlin constitution, binding bans and rules have to be based on laws which must have passed the Berlin parliament (“Abgeordnetenhaus”). Legislative proposals for laws typically originate from members of the parliament or the government (“Senat”). However, legislative proposals may also be initiated by individuals. More explicitly, under Articles 61-63 of the constitution, citizens may file a petition asking for a referendum on issues for which the state of Berlin has legal competence; a referendum may aim, for instance, to enact, amend or repeal a local law.¹

The referendum on the closure of Tempelhof airport has been the first ballot poll on a specific issue in Berlin. There have been initiatives before, but none of these referendum demands has actually led to a poll, mainly because the initiators failed to turn in the minimum number of supporting signatures of eligible voters. The “Interest Group City Airport Tempelhof”, in contrast, easily met the required minimum of 20,000 supporters; the group started its campaign on November 29, 2006 and collected 33,773 signatures by the end of March 2007. Also the next hurdle was taken by a wide margin. According to Article 63 of the Berlin constitution, for taking a referendum, 7% of the electorate (i.e., 170,385 voters) have to express their official support for the initiative by giving a signature in front of a public official (at Berlin district townhalls) within four months time. After the end of the signing period from

¹ The constitution is available online at <http://www.berlin.de/rbmskzl/verfassung> (in German).

October 15, 2007 to February 14, 2008, 204,907 Berlin citizens (~8.4% of the eligible voters) had officially asked for a referendum which was finally held on April 27, 2008.

The broad public support for the referendum probably results from many sources, but is perhaps mainly due to the fact that there has been little obvious reason for the closure of Tempelhof airport. Tempelhof has a living history, offers a locational advantage as inner-city airport, and there is (still) no concept for the future use of this area. So, why is Tempelhof to be closed?

The decision actually reaches back to the early 1990s when, shortly after reunification, there was broad agreement among policy-makers that air traffic in the region should be concentrated at a single airport. At this time, Berlin and the surrounding state of Brandenburg were operating three airports, mainly due to German division, with two of these airports being located in the former western part of the city of Berlin. However, especially traffic at these two inner-city airports, Tegel and Tempelhof, was widely viewed as being potentially problematic for the future air traffic infrastructure in the reunified region. With the expected further increase in air travel, the inner-city location of these airports provided serious limits for a future expansion in passenger transport capacity. More importantly, flight operations at these airports were associated with elevated noise exposure and heightened risk of disaster for inner-city districts. As a result, decision was made to give up the system of airports in the region for a single airport, especially since the projected traffic volume for the region is properly handled by one large airport. After an extensive review of several possible locations for the new airport, accompanied by various forms of protest by local opponents, high-level representatives from the state and federal governments (that is, the mayor of Berlin, the governor of Brandenburg, and the federal transport minister) decided in 1996 to rebuild and expand Schönefeld airport.² Not surprisingly, this decision generated an immense number of appeals (mostly by nearby residents); more than 4,000 persons took this issue to court. Although these appeals were generally unsuccessful, the Federal Administrative Court of Germany (“Bundesverwaltungsgericht”) ruled, when deciding some of these cases, that an extension of Schönefeld airport without closing the two inner-city airports is not justified.³ Based on this ruling, the Berlin city government emphasized, besides environmental aspects, legal reasons for their insistence on the closure of Tempelhof; a departure from the original

² For a more detailed exposition of the arguments that have led to the decision to expand Schönefeld airport, see the state development plan; the plan is available online at <http://gl.berlin-brandenburg.de/imperia/md/content/bb-gl/landesentwicklungsplanung/lepfs.pdf> (in German).

³ <http://www.bverwg.de/media/archive/3832.pdf> (in German).

plan to close the inner-city airports would risk project (and investment) failure. A third set of arguments focuses on economic issues. With the relocation of airlines, air traffic in Tempelhof has been in decline; because of low revenues and sizable operating expenditures (which are to a large part unrelated to traffic volume), the airport has been losing money for years.

Supporters of Tempelhof airport, in contrast, highlighted the costs of airport closure. With no flight operations, jobs and revenue are lost, while there still remain sizable fixed costs (e.g., for security and maintenance). In addition, closure would imply destruction of a local advantage and the demolition of a city's landmark.

In view of these conflicting arguments, voters were asked to decide on the future of Tempelhof airport. At the end of March 2008, all eligible voters (i.e., voters eligible to vote in elections for the Berlin parliament) received an information brochure about the referendum along with their notification. The ballot poll was finally held on April 27, 2008. In the poll, voters were confronted with a single yes-or-no question. More specifically, they were asked to express their opinion on the following statement: "The inner-city airport Tempelhof provides relief and complementary capacity to the commercial airport Berlin-Brandenburg International (BBI). The Berlin government is requested to abandon their intention of closure immediately and to lift the cancellation of the operating licence. Tempelhof must remain a commercial airport! Do you agree with this resolution? Yes/No".

Interestingly, political parties took position on this issue and gave clear recommendations for voting. The two left-wing parties in government (socialdemocrats and former communists), not surprisingly, defended the decision to close Tempelhof airport. Also, environmentalists (greens) were in favour of closure. The two main opposition parties (christian democrats and liberals), in contrast, heavily criticized the decision of the authorities; they were, in fact, strong supporters (and to some extent even initiators) of the campaign to keep Tempelhof airport operating. In total, these five political parties accounted for about 86% of the votes during the last elections for the Berlin parliament (on September 17, 2006).

The referendum on Tempelhof airport failed. Of the 881,035 votes that were cast, a 60% majority requested continued flight operations in Tempelhof. However, the number of supportive votes (529,880) fell short of the required quorum of 25% of the electorate (which would have required 609,509 yes-votes), mainly because of low voter turnout of only about 36%. As a result, air traffic at Tempelhof airport was suspended, as planned by authorities, on October 30, 2008. The official licence expired in mid-December 2008.

4. Methodology and Data

Individual preferences for airport location may be affected by various motives. A first set of motives is related to pecuniary economic aspects. For instance, as already well documented, residential property prices are often lower in the vicinity of airports. As a result, property owners tend to lose from (and therefore typically oppose) airport location/expansion, while (noise-resistant) renters of homes may benefit from lower rent levels. Moreover, since airports provide access to (travel) services, customers and suppliers of these services have an incentive to locate close to the airport to minimize commuting costs.

Another set of motives focuses on intangibles. The most prominent intangible of airport operations is aircraft noise; in the vicinity of airports, people are exposed to elevated sound levels which may cause negative health effects such as stress, annoyance, hearing impairment and sleep disturbance. Other potential disamenities of flight operations include increased pollution, greater insecurity because of the higher risk of plane crashes during take-off and landing, and extensive airport-related commuter traffic.

Finally, it has recently been argued that preferences can be adaptive to existing institutions; see Alesina and Fuchs-Schündeln (2007). Therefore, Tempelhof residents (who have been exposed to airport noise for years) have perhaps become accustomed to nearby flight activities and thereby rather voted for continued operations.

In the following, I analyze empirically the relative importance of these preferences for airport location by examining voting behavior. The referendum on Tempelhof airport provides, for the first time, evidence on people's overall assessment of airports; exploring local differences in voting results then allows identifying factors of importance in individual cost-benefit analyses of airport location.

Reviewing potential determinants of voting behavior on Tempelhof, three issues appear to be of particular relevance. First, individual pecuniary interests have been probably of minor importance for voting preferences. Given that the future development of the airfield in Tempelhof is not yet decided, the impact of airport closure on local property prices is unclear. Also, the small scale of regular flight operations at Tempelhof airport clearly limits the attractiveness of this airport for frequent travellers. In 2007, seven airlines offered flight services from Tempelhof to 54 destinations in five countries (with Brussels and Copenhagen being the main destinations). Tegel airport, in contrast, is served by 57 airlines, offering connections to 113 destinations in 41 countries. Second, voting on Tempelhof may be another example to illustrate the role of adaptive preferences. Since Tempelhof airport has a strong symbolic value for residents in the western part of the city, voters close to the airport may also

have a preference for ongoing operations (despite their disamenities). Third, voting patterns on Tempelhof may have been affected by political preferences. Political parties gave clear recommendations on voting. In fact, the referendum campaign on Tempelhof airport has been, at least in part, an initiative by major opposition parties to generate a vote of no confidence for the ruling coalition in the Berlin city government. As a result, some voters perhaps went to poll for political reasons even though they have no position on the referendum issue.

In practice, voters may have expressed their preferences about Tempelhof airport in the referendum in two separate ways. On the one hand, voters may have answered the question about flight operations in Tempelhof directly by participating in the ballot poll. On the other hand, people may have shown disinterest in this issue by ignoring the poll, thereby effectively weakening the campaign to keep Tempelhof open. In the empirical analysis, I use the percentage of yes-votes and voter turnout as measures of support for Tempelhof airport.

The referendum on Tempelhof airport has been a secret poll so that individual voting behavior is not known. However, voting results are available for a spatially finely disaggregated grid of local polling places in Berlin. In total, there have been 1,201 local polling places where the referendum was taken; these places (mostly located in public schools) covered areas of different geographic size, but were set up for on average about 2,000 eligible voters. Figure 1 provides a map of these areas along with the percentage of yes-votes.

A potential problem is that a sizable fraction of the electorate voted by mail; about 26% of the votes (230,571) were not taken at polling places but sent by mail so that the resident location area of the voter cannot be determined exactly. Fortunately, however, voting patterns do not differ by the mode of vote taking. Figure 2 graphs the percentage of yes-votes for ballot votes and mailed votes by city district. With a correlation of 0.99, the differences in voting patterns appear negligible.

In the empirical analysis, I examine differences in voting results on airport closure across local polling places. The key explanatory variable of interest is local exposure to airport noise from Tempelhof airport. If airport noise (and other flight-related disamenities) is of major importance for the location decision of Berlin citizens, residents located close to the airport should have a particular interest in closure of Tempelhof; the disappearance of flight-related disamenities would then imply, for these residents, a sizable gain (e.g., in their quality-of-living), without any visible losses.

In addition, I include a number of other explanatory variables. The benchmark model includes, for instance, a binary dummy variable that takes the value of one if the polling place is located in the former western part of Berlin; this variable allows capturing the symbolic

value of the airport (as a symbol for freedom), possibly reflecting adaptive preferences. Measures of political orientation control for party preferences. In sum, I run OLS regressions of the form:

$$\text{Vote}_i = \alpha + \beta \text{THF}_i + \gamma X_i + \varepsilon_i,$$

where Vote_i is a measure of the referendum outcome at polling place i , THF_i is the extent of disamenity from Tempelhof airport at i , X is a vector of other control variables, and ε is a (hopefully) well-behaved residual.

Data on voting results by polling place are obtained from the state statistical office of Berlin-Brandenburg.⁴ The data set contains, for each polling place, information on the number of eligible voters, the number of votes cast and the number of yes- (and no-)votes. Based on this data, I compute the share of yes-votes and voter turnout at each polling place; these variables measure local preferences for continued airport operations in Tempelhof, used as dependent variable in the analysis (Vote_i). The same source is used for information on local political preferences; I use the results from elections for the Berlin parliament on September 17, 2006.⁵

Local disamenities of Tempelhof airport (THF_i) are proxied by airport noise levels. These data are provided by the Berlin city government. Since these data cover only a small geographic area of affected polling places, I use distance to Tempelhof as an alternative proxy.

5. Empirical Results

Table 1 presents the benchmark results. I begin by examining differences in voting patterns on Tempelhof airport as measured by the percentage of yes votes for the initiative to keep the airport open. The main variable of interest is the level of airport-related noise. As shown in column 1, the estimated coefficient on this measure, though negative, is statistically indifferent from zero. As a result, voting behavior appears to be unaffected by disamenities related to operations at Tempelhof airport. Much stronger results, in contrast, are obtained for other potential determinants. For instance, the coefficient on a dummy variable for location of a polling place in the former eastern part of Berlin is significantly negative, indicating greater

⁴ I am grateful to Geert Baasen from the bureau of the election supervisor at the state statistical office of Berlin-Brandenburg for the provision of the data. Other useful information on the Tempelhof referendum (including a copy of the ballot paper) is available online at <http://www.wahlen-berlin.de/wahlen/framesets/ve-2008.htm>.

⁵ For some polling places, there has been a minor redesign in the geographic area that is covered. As a result, the number of polling places with usable data falls to 1,197.

support for closure of the inner-city airport in territories without any historic relationship to the airport; this finding strongly confirms previous evidence on adaptive preferences in Alesina and Fuchs-Schündeln (2007). Similarly convincing results are obtained for political preferences; voting results are strongly correlated with preferences for political parties during the last elections.

Next, I replace Tempelhof-related noise with distance to Tempelhof airport. In column 2, distance is proxied by dummy variables for the location of a polling place in circles of varying distance around Tempelhof airport. Surprisingly, estimated coefficients on these measures are, if anything, positive, suggesting that opposition to closure is disproportionately large in the vicinity of this airport. Thus, disamenities of airport operations for residents are apparently compensated by other factors.

Using a broader measure of continuous distance from Tempelhof airport (that also considers differences in voting results for polling places not directly affected by airport operations) gives conventional results; the percentage of yes votes is higher the larger the distance to Tempelhof airport. Results are tabulated in column 3.

Column 4 extends the analysis to distance to other airports. More specifically, I add a measure for distance of the polling place to the nearest airport. The results for this specification are interesting. As before, the estimated coefficient on the distance measure is significantly negative; voters in the vicinity of airports tend to oppose operations at Tempelhof airport, even though they are located close to another airport. After controlling for this effect, residents in the vicinity of Tempelhof display significantly smaller opposition to airport operations.

The final column in Table 1 again tabulates conventional results. Opposition to airport operations in Tempelhof is disproportionately large in the vicinity of airports (other than Berlin-Tempelhof).

I have performed extensive sensitivity analyses. In various robustness checks, I have used voter turnout as dependent variable, I have included the full set of election results (covering 28 political parties and groups), and I have added other explanatory variables (such as the number of votes that were taken at a given polling place). The main findings were robust to these perturbations.

6. Conclusions

Traffic noise is annoying. In this paper, I examine new evidence on the costs of airport-related noise (and other disamenities of airports) for individuals. In contrast to

previous work which has mainly focused on property prices to document the costs of airport noise, I analyze voting results from a recent city-wide ballot poll on airport closure; direct voting should provide useful insights on the overall assessment of the costs and benefits of an airport by residents. Using data from a referendum on the closure of one of Berlin's inner-city airports, Tempelhof, I find that voting behavior is neither affected by airport distance nor by airport-related noise exposure. In contrast, strong opposition to closure in the vicinity of Tempelhof indicates that adaptive preferences may be important.

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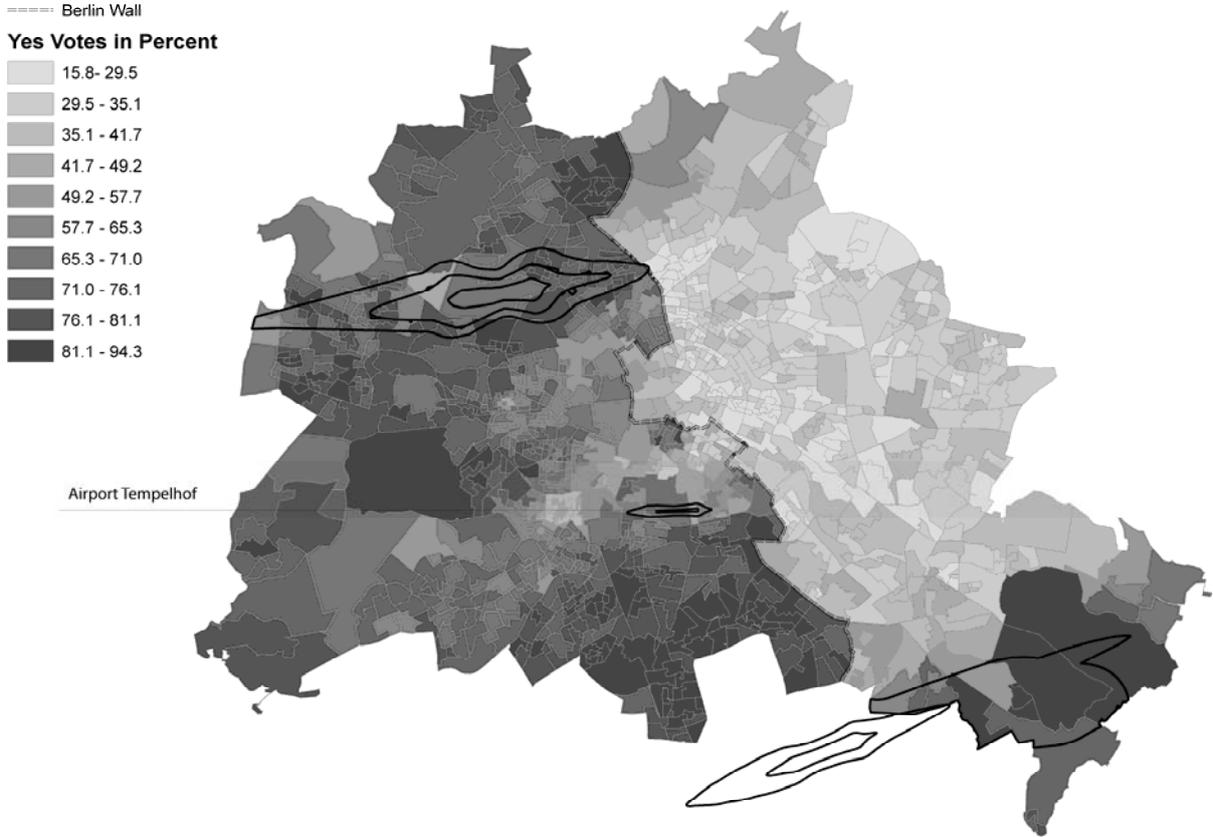
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Table 1: Benchmark results

Noise_THF	-0.031 (0.064)				
THF 0-2km		0.908 (1.723)			
THF 2-4km		1.715* (0.872)			
THF 4-6km		0.288 (0.647)			
Distance_THF			-1.145** (0.437)	1.315** (0.496)	
Distance_Airp.				-5.229** (0.557)	-6.316** (0.910)
Airp. 0-2km					-4.855* (2.167)
Airp. 2-4km					-2.559* (1.132)
Airp. 4-6km					-0.899 (0.654)
East	-6.248** (0.805)	-5.871** (0.834)	-5.845** (0.818)	-5.006** (0.795)	-5.192** (0.810)
SPD	-8.831 (8.038)	-5.952 (8.274)	-9.374 (7.946)	-6.768 (7.675)	-12.872 (8.112)
CDU	20.409** (7.472)	22.634** (7.646)	21.779** (7.470)	30.683** (7.272)	27.060** (7.422)
Linke	-126.377** (6.863)	-124.365** (7.015)	-126.415** (6.835)	-110.737** (6.805)	-114.854** (6.829)
FDP	20.556* (10.486)	26.704* (10.967)	23.764* (10.525)	43.933* (10.383)	40.921** (10.623)
Grüne	-91.192** (5.382)	-91.122** (5.472)	-93.595** (5.445)	-83.735** (5.359)	-90.017** (5.332)
Adj. R2	0.88	0.88	0.88	0.88	0.88

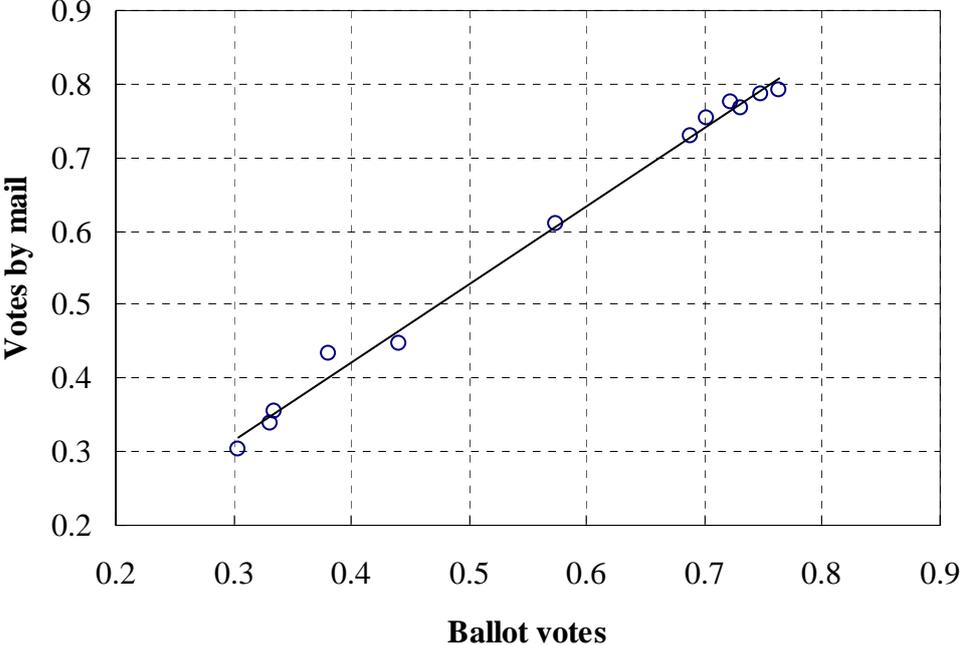
Notes: OLS estimation. Dependent variable: Referendum outcome (% yes-votes). Standard errors are reported in parentheses. **, * and # denote significant at the 1, 5 and 10 percent level, respectively. The number of observations is 1,197.

Figure 1: Map of Berlin



Notes: The map shows the areas of polling places, the noise corridors of Berlin airports, and a rough classification of referendum results. Groups have been defined according to the “natural break method” by Jenks (1977); this method identifies breaks in the ordered distribution of values that minimize the within-class sum of squared differences.

Figure 2: Referendum results by mode of vote taking



Notes: The figure shows the percentage of yes-votes by mode of vote taking for the 12 Berlin city districts.