Sensitivity of Prices to Demand Shocks:

A Natural Experiment in the San Francisco Bay Area

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Abstract

We analyze the impact of a freeway interchange collapse in the San Francisco Bay area on the difference in airfare quotes for travel into the area's main airports. The incident temporarily made Oakland airport a less attractive choice for traveling to San Francisco, so we hypothesize that fares for travel into Oakland will be relatively lower while the freeway interchange was out of service. We test our contention using a sample of fare quotes collected on-line, and find the expected effect of a magnitude of 6-7 percent. Our results imply the following important conclusions. First, the demand-side shock was absorbed by the supply side. Second, adjustment of prices and return to the status quo once the shock vanished was swift.

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1. Introduction

It is a well-established fact that economists' ability to conduct controlled experiments is limited. However, unexpected events which change economic agents' incentives do happen, and these events may allow researchers to gain some insights on how firms and consumers behave in the naturally occurring world versus how fundamental economic theories suggest they should behave.

This paper looks at one such event – the collapse of a freeway interchange connector at the McArthur Maze in the San Francisco Bay Area following a tanker truck accident on April 29, 2007. This unpredicted incident altered for a short time period the degree of substitutability between the area's main airports (most notably between San Francisco International (SFO) and Oakland International (OAK)). People traveling to the city of San Francisco would temporarily find Oakland a less attractive airport to fly into/from, due to increased expected travel time (and higher expected variance thereof) between the airport and the city, due to the increased congestion on a major freeway leading to the airport. Such a change in substitutability should be reflected in lower than normally expected demand for flights from/into OAK as compared to the area's other airports. Since the airlines tend to adhere to their published schedules and are unlikely to respond to this demand shock by temporarily cutting their capacity[1], our expectation is that the fares for flying into OAK should be lower while the freeway interchange was out than after the reconstruction has been completed. Alternatively, airlines could keep the prices fixed at the pre-collapse level and decrease the yield (i.e., sell fewer full fare seats for trips

[1] According to T-100 dataset of the US Department of Transportation, total capacity (in terms of number of seats offered by the commercial airlines in connection with their scheduled services within the United States) increased across all three area airports from April to May 2007 (by 2.5 percent at Oakland, 7.5 percent in San Francisco, and 4.2 percent in San Jose). From May 2007 to June 2007, the capacities at all three airports remained flat. As we will discuss later, such capacity adjustments will only reinforce our story.

to OAK). In simple economic terms, the first strategy amounts to adjusting prices while the second strategy leads to absorbing the shock with quantity adjustment.

The collapse of the interchange provides us with a clearly exogenous shock with known timing. Notably, we know that the shock evidently affected the demand side of the market and it had little effect on the supply, so that we have a clear identification of the short-run supply curve. We therefore get a rare opportunity at studying how the demand-side shock has been absorbed by the supply side.

In addition to providing us with a 'quasi natural experiment' setting, the incident gives us a rare opportunity of analyzing the impact of a 'surface transportation infrastructure disaster'. In addition to counting the extra time spent in traffic jams or estimating the number of trips not taken due to the incident, we demonstrate that the impact of a road infrastructure disruption spreads beyond roads to the related industries which rely on roads. Our study thus underscores the importance of the surface road infrastructure for communities and the economy.

For the purpose of the empirical analysis, we collected (via a major travel agent and some of the individual airlines' web sites) price quotes for travel to each of the three major airports in the San Francisco Bay Area from eleven large U.S. metropolitan areas (combined, these areas are home to more than a quarter of the U.S. population). Focusing on the last minute fare quotes, we conducted our data collection exercise weekly, starting ten days after the freeway interchange collapse, and finishing at least six weeks after the planned completion of rebuilding the interchange.[2]

Data analysis revealed that the effect of the freeway interchange collapse was to widen the gap between the fares for travel into OAK versus other two area's

[2] Actually, the interchange was completed less than a month after it collapsed; and more than a month ahead of announced schedule – see next section of the paper for details.

airports by approximately 6-7 percent so that travel into OAK was relatively cheaper than into other airports. We also suggest that the demand shock has been fully (or at least to a substantial degree) absorbed by the supply side of the market (airlines), as the size of the fare reduction effect is not inconsistent with the value of additional travel time for a likely passenger due to congestion that the freeway interchange collapse might have produced en route from the city of San Francisco to OAK airport (see background information section below for details). While we are unable to accurately assess how fast the downward adjustment was following the shock, the 'return to status quo' after the shock ended was almost immediate. Hence, we find no price stickiness in airfares.

In addition to studying absorption of the demand shock by the supply side of the market; our natural experiment can be related to several broad issues in the economic literature. First, this study can be related to the literature on product differentiation. Specifically, we examine the impact of an event which effectively lowered substitutability between the area's airports by decreasing the perceived 'quality' of one of them. Second, the paper contributes to the literature examining the effects of road congestion. Yet, unlike other studies on this issue, which look at the 'longer-term' impact of road congestion outside roads[3], our paper analyzes an immediate impact of a change in road congestion conditions. Forbes' (2008) study on the link between increased congestion at New York's LaGuardia airport and the airfares is closely related to our work (yet, that study examined the connection between the *airport* congestion and airfares). Third, we investigate the degree of price stickiness in the airline industry and thus provide evidence on the sensitivity of prices to an exogenous demand shock. Our results complement previous literature

[3] The most popular topics here are impact of congestion on property values – see Mohring, 1962, Arnott and Stiglitz, 1981, Glazer and van Dender, 2005 – and public transit usage – e.g., Small, 2004.

documenting the duration of prices across goods by effectively constructing dynamic responses of prices to an exogenous shock and thus providing a qualitatively new type of evidence on price stickiness.

The rest of the paper is organized in the following way. Section 2 provides background information on Bay Area airports and the accident. Section 3 discusses the data collection process. Section 4 describes the data analysis methodology and results. Section 5 concludes.

2. Background

2.1. Bay Area Airports

Commercial airline flights to/from the San Francisco Bay Area are handled by the three main airports: San Francisco International (SFO); Oakland International (OAK), and Norman Y. Mineta San Jose International (SJC). In 2006, SFO handled around 24 million domestic passengers; OAK domestic traffic was about 14 million; and slightly more than 10 million passengers were handled by SJC. SFO is also the area's main hub for international air traffic, with over 8 million passengers handled in 2006. In relative terms, OAK is the fastest growing airport of the three (over 2002-2006, the number of passengers handled by this airport increased by over 20 percent; at the same time, SFO reported about 16 percent increase in passenger traffic, while SJC's traffic stayed flat).

At each of the airports we can identify an airline which can be considered a dominant carrier. Specifically, the market share of United Airlines at SFO is currently about 43 percent (in terms of the number of passengers carried); Southwest Airlines is the dominant airline in both OAK (63 percent of passengers) and SJC (over 40 percent market share). All numbers relate to passenger traffic on the U.S. domestic routes.

To give the reader a better idea of the airports' location relative to the cities they are named after (which also happen to be the area's major cities), the following table lists distances and driving times between the airports and downtown areas of San Francisco, San Jose, and Oakland, as reported by Google Maps. From that table it is clear that OAK and SFO are closer substitutes compared to the other two airport pairs.

[Table 1 here]

2.2. Freeway Interchange Collapse

In the early morning hours on April 29, 2007, a tanker truck accident led to a fire which destroyed the connector between eastbound interstate freeway 80 and eastbound interstate freeway 580. The accident took place at one of the most important freeway intersections in the San Francisco Bay Area – the so-called McArthur Maze. This knot, located in Oakland not far from the Bay Bridge, is the place where freeways 80 (a major interstate starting in San Francisco, leading north to Sacramento, and eventually crossing the country to end in New Jersey), 880 (a road that starts at the McArthur Maze and goes along the San Francisco Bay to end in San Jose), and 580 (a freeway that starts in San Rafael, north of San Francisco, and goes to Oakland across the San Pablo Bay, northeast of San Francisco, and continues further inland to end in the California Central Valley, merging into southbound Interstate 5) meet. Figure 1 below depicts the main freeways at and around the McArthur Maze, showing the location of the affected interchange, as well as the location of the area airports relative to the Maze. Figure 2 puts Figure 1 into a broader context, showing the location of the McArthur Maze relative to the Bay Area's main airports.

[Figure 1 here]

[Figure 2 here]

The effect of the accident on commuters has been less severe than initially anticipated. The Bay Area Rapid Transit (BART) increased its capacity following the accident; residents were urged to use public transportation, carpool, telecommute, and use ferries as much as possible. Also, the accident happened on a Sunday morning, which gave authorities the entire day to inform the residents, and provided commuters with sufficient time to assess their options for commute on the following Monday and in the near future. The destroyed connector was of course used only by a portion of area commuters, and utilized more in the afternoon than in the morning commute (as it is the connector leading out of San Francisco).

Reconstruction work started almost immediately after the collapse. Only a week following the accident, the connector onto which the 80 to 580 one fell (the westbound 80 to southbound 880 connector) was reopened for traffic. Later on that day, Caltrans[4] awarded the contract for replacement of the lost connector, with the target completion date of June 27, 2007. The contract specified $200,000 a day in bonuses for completing the work before the target date, and equal penalties for late completion. The contractor (a firm with experience of rebuilding freeways after the 1994 Northridge earthquake in Southern California) bid low, anticipating finishing the work early and collecting a hefty bonus. And collecting the early completion bonus it did, reopening the collapsed interchange on the evening of May 24, 2007, only 25 days after the collapse and over a month before the target date. Appendix Table A.1 presents the timeline of the events.

2.3 Freeway Interchange Collapse and Road Congestion

[4] Also known as the California Department of Transportation.

One can be skeptical that the freeway interchange collapse could have affected the airfare differentials between the Bay Area airports on the following grounds. First, the accident occurred away from the route leading from San Francisco into Oakland airport. Second, it is not clear to what extent the three Bay Area airports are considered substitutes by the customers – that is, how likely a person traveling to San Francisco is to go into Oakland airport in the first place. Finally, with public transportation options available in the Bay Area, travelers could simply adjust their behavior following the accident by taking transit.

It is evident from Figure 1 that the freeway interchange collapse occurred away from the major roads leading to the airports. We cannot however say that this event did not have any potential to affect the motorists driving to Oakland International Airport from San Francisco. Indeed, traffic which previously went straight from eastbound 80 to eastbound 580 (from San Francisco inland, including to downtown Oakland, after crossing the Bay Bridge), now had to make a detour using southbound 880, thereby adding to the San Francisco to Oakland airport traffic. Given that interstate 880 is part of the truck transportation corridor – meaning a good number of heavy-duty vehicles on the road at any time – additional traffic may mean congestion on the previously not congested road.

To give the reader an idea of the volume of traffic involved, consider the following numbers. According to the California Department of Transportation data, peak time traffic on freeway 580 East of the interchange with freeways 80 and 880 amounts to 17,800 vehicles an hour; whereas just before the interchange to North 80 (after cars going to/from San Francisco and freeway 880 left 580) the road only handles 7,000 vehicles an hour at peak time. In the 'worst case scenario' this would mean that over 10,000 vehicles could be returning at an afternoon peak hour from San

Francisco using the collapsed interchange. If they all were to enter 880 going towards OAK airport, we would observe 10,000 more vehicles per hour on a road handling around 13,000 vehicles in a peak hour already – nearly double the usual traffic.

This 'worst-case scenario' is a dramatization. Yet, we can reasonably suggest that while the eastbound 80 to eastbound 580 interchange was out, we might (at a normal peak hour) observe several thousand more vehicles sharing southbound 880 with OAK airport traffic. Given the average peak-hour traffic volume on that stretch of 880 (around 13,000 vehicles per hour, both directions), even 2,000 vehicles returning from San Francisco would amount to about 15 percent increase in peak-hour traffic; moreover, assuming 880 traffic is split equally between northbound and southbound (this would be 6,500 vehicles per peak hour in either direction), our hypothetical but not unreasonable 2,000 extra vehicles will amount to about 30 percent increase in OAK Airport bound traffic from San Francisco during peak hours. On four-lane[5] stretches of 880, the increase in traffic we discussed above would mean that the number of vehicles per peak hour per lane would increase to 2,125 from 1,625. According to the Highway Capacity Manual, a highway becomes congested once traffic volume reaches 2,000-2,200 vehicles per hour per lane. Therefore, our hypothetical but quite a probable scenario implies that the freeway interchange collapse could have contributed to creating congestion where it was not present before. Thus, to a certain extent Oakland could have become a less attractive option relative to SFO at the time the freeway interchange was out.

2.4 Substitutability between airports

The evidence that Oakland International is indeed considered an alternative to San Francisco International by the travelers whose final destination is across the Bay

[5] The 880 freeway has 4-5 lanes in each direction.

Bridge from Oakland can be found in the Survey of Air Passengers from the Bay Area's Airports, last conducted in 2001 and 2002 by Charles River Associates. According to that survey, we can say the following:

- Business travelers are more likely to use SJC and OAK than SFO, the SJC-SFO difference being larger than the OAK-SFO difference;
- Travelers whose trips originate in the City of San Francisco (these include either travelers living in San Francisco or staying in a hotel in the city) are more likely to fly out of OAK airport, as compared to the likelihood of encountering a traveler whose trip originated in Oakland area in San Francisco airport;
  - More specifically, 16 percent of all travelers surveyed in OAK airport started their trips in San Francisco (extrapolating this number to 2007 OAK traffic, we will get over 1 million travelers who have or will have used OAK during 2007 going to/from San Francisco); whereas ten percent of SFO travelers came to the airport from Alameda County, which includes Oakland.
  - Furthermore, a quarter of all surveyed passengers started their trips in the city of San Francisco.
- Travelers originating their trips in the city of San Francisco are very unlikely to fly out of SJC;
- There is some substitutability between SJC and SFO for residents of San Mateo county (the one located between San Francisco and San Jose); otherwise, SJC is the most 'local' airport of the three, with three quarters of its passengers originating their trips in either San Mateo or Santa Clara (the one which includes the city of San Jose) counties.

In general, while passengers do tend to prefer airports closest to their home or place of business, the preferences are not entirely lexicographic, and substitution takes place (see also Ishii et al., 2009). Moreover, San Francisco residents (and/or travelers whose destination is in San Francisco) are rather eager to choose an airport other than SFO, in which case they tend to prefer OAK over SJC. Other studies based on this survey reached the following conclusions. Pels et al. (2001) show that travelers appear to choose airport first and airline – later; the same authors' 2003 paper demonstrates that travelers surveyed at the area airports exhibit high value of time. Basar and Bhat (2002, 2004) indicate that access time is an important determinant in the travelers' choice of the airport.

Although the survey was conducted in 2001 and 2002, it is unlikely that the substitutability between the airports decreased. In fact, sizeable changes in recent years could only have reinforced the substitutability between OAK and SFO, documented in the survey. Specifically, JetBlue Airways increased its market share at OAK from 5.3 percent in 2002 to nine percent in 2007, marketing OAK as an alternative to SFO, and only entering the latter in 2006. Southwest, having over the same time period grown to become the airline carrying more passengers on routes within the US than any of its competitors, also emphasized OAK as the gateway to San Francisco area (entering SFO during and shortly after we finished collecting the data for this study)[6]. Furthermore, United Airlines (traditionally the dominant carrier at SFO) spent some time after 2001 under bankruptcy protection, re-emerging as a smaller carrier. Indeed, United Airlines' market share at SFO fell from 53 percent in 2002 to 43 in 2007.

[6] Presently, Southwest Airlines boasts 63.3 percent market share in OAK (this is larger than Delta Air Lines' market share at the Atlanta airport).

Finally, while public transportation (including airport access by same) in the San Francisco Bay Area is more developed than in, for example, the Greater Los Angeles Area, the above-mentioned survey of air travelers clearly states that around 80 percent of travelers surveyed got to OAK airport by a personal vehicle (whether private or rented); the same number for SFO was about 68 percent. While this percentage could have been lower during the event we study, we have little reason to believe it dropped substantially below the numbers reported above.

3. Data

The majority of the data used for this study was collected via Orbitz (www.orbitz.com) – one of the big three on-line travel agents on the US air ticket distribution market.[7] Since this particular travel agent did not at the time offer fare quotes by the two important low cost carriers serving the San Francisco Bay area airports (Southwest and JetBlue), we had to collect fares offered by those carriers from their web-sites. While JetBlue did at the time sell its tickets via another leading on-line travel agent (Travelocity), we chose to go to the carrier's web-site instead, as some travel industry experts indicated to us that it was not clear at the time whether one would necessarily find the carrier's best deals with that travel agent.

The data collection exercise was centered on the notion of a last minute traveler on a short trip, willing to choose between the metropolitan area's airports in search of a deal. This strategy has two advantages. First, we can work under an assumption that our hypothetical customer knows she will travel, and therefore does not care whether the ticket is refundable or not.[8] Second, differences in fare quotes across the airlines closer to the departure date are likely to reflect differences in

[7] The other two are Travelocity and Expedia: altogether, about one in five air tickets for travel within the United States is sold via these three travel agents.
[8] This is particularly important as there are clear differences between carriers in this respect: for example, at the time of our data collection exercise JetBlue did not offer any refundable tickets (it only started doing so later in 2007).

realization of demand for the carriers' services, as the companies known to practice yield management set fares based on the number of empty seats on flights.[9]

The fare quotes were collected every Tuesday (for departure on Wednesday and return on Friday of the same week). We obtained the data on sixteen different dates starting from the week of May 08 to August 21, 2007. Since we collected the data once a week, we will use the terms like "day of data collection" and "week of data collection" interchangeably throughout the paper. Table A.1 in the Appendix contains detailed information on data collection dates relative to the freeway interchange reconstruction project milestones. As a reminder, the accident occurred on April 29; the planned completion date was June 27; and the freeway interchange actually reopened on May 24.

On each day of data collection, we gathered fare quotes for travel to each of the three San Francisco Bay area airports from eleven large metropolitan areas (combined, these are home to about a quarter of US population). Thus, on each date of data collection, we made three queries on Orbitz for travel to each of the San Francisco area airports; in addition to that, we collected fare quotes on Southwest Airlines' and JetBlue Airways' web-sites. Some of the origin areas are served by multiple airports – in which case we searched across all the area's airports. The following metropolitan areas have been included into our analysis:

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[9] One can legitimately claim that even though we suppose our hypothetical customer's travel uncertainty has been realized; he may at the same time still prefer some flexibility, especially with respect to being able to change the time of the return flight (in which case the assumption that our traveler does not care about whether the ticket is refundable or not seems not to be valid). However, once the passenger has embarked upon the roundtrip journey, he will have to come back, whether on the flight he originally had his reservation on or on a different one. Then, conditional on the customer traveling, the difference between the refundable and the non-refundable ticket is similar to that between a lottery and a certain outcome (see also Escobari and Jindapon, 2009). Also note that once (and even before) the trip has begun, a customer on a non-refundable ticket can change his travel plans for a fee. In summary, travelers with refundable and non-refundable tickets should feel similar effects from the freeway collapse.

- Boston, Massachusetts – served by Boston Logan International Airport (BOS). Southwest Airlines markets nearby Providence, Rhode Island, and Manchester, New Hampshire airports as alternatives to flying directly into Boston Logan. These are however not such a close substitutes to BOS[10]; therefore, no Southwest Airlines' fare quotes for travel from Providence and Manchester were collected.
- Chicago, Illinois – served by O'Hare (ORD) and Midway (MDW) airports; Southwest Airlines' services are from MDW; when searching on Orbitz, we used airport code CHI, which searched both airports.
- Denver, Colorado – served by Denver International (DEN).
- Dallas/Fort Worth, Texas – served by Dallas Fort Worth International (DFW) and Dallas Love Field (DAL). Southwest only flies out of DAL, and its ability to provide non-stop services to San Francisco area is restricted by the Wright Amendment.[11] Therefore, we did not collect Southwest Airlines' fare quotes for travel out of this area.
- Miami, Florida – includes Miami International (MIA) and Ft. Lauderdale (FLL) airports.
- New York City (includes areas located in the states of New York and New Jersey) – includes John F. Kennedy (JFK), Newark Liberty (EWR) and LaGuardia (LGA) airports. Code NYC that searches across the three airports was used for Orbitz queries. While Southwest Airlines technically serves the area flying into Long Island Islip (ISP) airport; we did not search for this airline's fare quotes out of this

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[10] They are located further away from the city; also, BOS is directly linked to the city of Boston via subway, unlike other gateways.

[11] The Wright Amendment is a federal law that limited flights out of DAL to Texas and adjacent states. While in October 2006 a law was enacted allowing carrying connecting passengers from DAL to destinations outside of the Wright zone; non-stop flights to those destinations will only be available starting 2014.

gateway, as ISP is generally regarded not a very close substitute to JFK, EWR and LGA.

- Phoenix – Scottsdale, Arizona – served by Phoenix Sky Harbor International (PHX).
- Seattle – Tacoma, Washington – served by Seattle International Airport (SEA).
- Las Vegas, Nevada – served by Las Vegas McCarran International Airport (LAS).
- Houston, Texas – includes Houston Hobby (HOU) and George Bush (the father) Intercontinental (IAH) airports. Southwest provides its services out of HOU.
- Washington, D.C. metropolitan area (includes both District of Columbia and areas in the states of Maryland and Virginia) – this area is served by Ronald Reagan National (DCA), Dulles International (IAD) and Baltimore International (BWI) airports. We used code WAS to search across the three gateways.

One may want to include Los Angeles metropolitan area into analysis since Los Angeles to San Francisco market for air travel is one of the busiest in the USA. However, it is not clear how best to approach L.A. area's market, which features five airports offering services to San Francisco area (Los Angeles, Burbank, Long Beach, Ontario, and Orange County). Road congestion in Los Angeles area substantially affects the degree of substitutability between the airports; and there is no single code for the area's airports we can use. Moreover, unlike with the metropolitan areas included into our analysis, driving is a viable alternative (Google Maps quotes less than six hours' – 5 hours and 48 minutes – drive between downtown L.A. and downtown San Francisco; among the cities we included into our study, the closest match is Las Vegas, with estimated driving time to downtown San Francisco at eight hours forty minutes).

Following each query (for the return trip to a San Francisco area airport from the given metropolitan area) we recorded the following fare quotes. For *each airline offering those*, we noted the lowest fare quotes for non-stop and one-stop trips (we ignored fare quotes offered by multiple carriers as, statistically, interline trips amount for a negligible proportion of travel on the US domestic market)[12]. While one can claim that business travelers may prefer non-stop flights for the last-minute trips of short duration; we cannot exclude the possibility of travelers exhibiting loyalty to the airlines not offering non-stop services on the given route (or on the given days), as well as the chance that non-stop flights might be far from the customer's most preferred departure time.

While Bilotkach and Pejcinovska (2007) estimate that fare quotes for one-stop trips are higher for shorter flights; we nevertheless recorded those even for the shorter-haul markets in our sample, for the sake of consistency.[13] We ended up with 3,828 unique fare quotes. Analysis of the data we collected is presented in the next section.

4. Analysis

4.1 Data Description

We start our analysis by examining a different data source to see whether the freeway interchange collapse had any discernable impact on demand for air travel on the routes included into our analysis. Specifically, a dataset known as T-100 Segment collected monthly by the US Department of Transportation provides data on the number of passengers carried by the US airlines on all non-stop flights. We used this

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[12] While we in the process of the data collection exercise have not clicked through to see whether the quoted fares were indeed available; there is good evidence (e.g., Bilotkach and Pejcinovska, 2009) that major on-line travel agents do not engage in the 'bait-and-switch' practices (whereby the fare increases by the time one gets to the point of purchasing the ticket) on the US domestic market.

[13] When performing the data analysis, we did estimate our specifications without one-stop fare quotes for short-haul routes. We will discuss this issue further in this paper.

dataset to calculate the non-stop traffic to the three San Francisco area airports from all the metropolitan areas included into our analysis in May and June of 2007 (that is, while the freeway interchange was out and after it was rebuilt). The corresponding market shares and differences are presented in the following table.

As we can see from Table 2, between May and June of 2007 market share of Oakland airport fell only for three out of eleven metropolitan areas included in our analysis; furthermore, most of the substitution appears to happen between OAK and SFO. Thus, we can say (although superficially) that the event has indeed affected demand for travel to/from the Bay area in the direction we predicted.

[Table 2 here]

Now, let us take a look at our sample of fare quotes. Table 3 describes the distribution of our sample by the origin metropolitan area. Table A.2 in the Appendix gives the same information by market – a more detailed breakdown. Note that our sample includes quotes for both non-stop and one-stop travel, and the latter can and do end up being rather high – the numbers in the tables below suggest we have outliers more or less evenly spread out across the markets. For the entire sample, the 99^{th} percentile fare quote is about $1,550; and the 95^{th} percentile is close to $1,300.

[Table 3 here]

Table A.3 in the Appendix reports differences in average fare quotes, by market, averaged over the first three weeks of data collection (ending just before the actual reopening of the freeway interchange); first six weeks (ending three weeks after the actual project completion date, but two weeks before the target date of June 27, 2007); and first nine weeks (ending a week after the target project completion date). The table paints a mixed picture: for some origin airports, fares to SFO are much higher than those to OAK; for others the situation is quite the opposite. Following the reopening of the freeway interchange, those fare differences moved in different directions, too.

Although we can discern no obvious pattern of dynamics of fare quotes in our sample, this is hardly surprising given how many factors influence airfares. In the next section, we carefully examine the effects of the interchange collapse on airfares after controlling for a number of observable characteristics.

4.2 Hypothesis and Methodology

Our empirical strategy is based on the difference-in-differences approach. The null hypothesis of our analysis is that fares for travel into OAK airport were on average the same before and after completion of reconstruction work on the collapsed freeway interchange. In the regression context, we employ the following specification:

$$\begin{aligned}\ln(FareQuote_i) = \beta_0 + \beta_1 OAK_i + \beta_2 SFO_i + \beta_3 BeforeCompletion_i \\ + \beta_4 OAK_i \times BeforeCompletion_i + controls + error\end{aligned}$$

Under the null hypothesis of no effect $\beta_4 = 0$. The appropriate alternative hypothesis in light of all we said above is $\beta_4 < 0$.

In our regressions we controlled for the following effects, using appropriate dummy variables: Airline; Origin metropolitan area; Date of collection; Airline – origin metropolitan area; Airline – destination airport. Additionally, we included a dummy variable for fare quotes for one-stop itineraries, as well as the interaction of this dummy with the non-stop flight distance between the origin and the destination airports (including distance by itself did not make sense as this effect is captured by the origin metropolitan area dummies). Finally, we used a dummy variable for price quotes for code-share itineraries (that is, flights for which the operating carrier was different from the one selling the ticket); flights performed by the commuter airlines for major carriers were classified as those performed by the major carriers. Since least squares regression is sensitive to outliers, we drop the top 1 percent of fare quotes.[14]

While early completion of the repair work was doubtlessly good news for the area commuters; it also left us with only three collection days' worth of data on fare quotes before actual project completion date. We do have another 4-5 (depending on where you put June 27, which is both the planned project completion date and a Wednesday or a departure date in our data collection exercise) days worth of data on fare quotes before the *planned* repair completion date. This actually allows examining how fast fares adjusted following the disappearance of the demand shock.

4.3 Results

Table 4 and Figure 3 present main findings of our analysis. In Table 4, we report results for the entire sample and for the sub-sample excluding the data collected in August (our original research design was reasonably symmetric around the date of planned project completion; excluding August makes our data more symmetric around the actual project completion date). All specifications in Table 4 include both the Airline-Origin Metropolitan Area and the Airline-Destination Airport effects; we varied the "before completion" time period artificially to include the first three, six and nine weeks of data collection. Note that the actual project completion date (May 24) falls in week 3; while the target date initially announced by the governor of California is June 27, which falls in week 8 of our data collection exercise. The natural logarithm of the fare quote, net of taxes and fees, was used as a dependent variable in all regressions.

[Table 4 here]

[14] Estimates for both the entire sample and the sample without top 5 percent of quotes are similar to those reported below.

Table 4 demonstrates presence of the effect we conjectured. In particular, the Oakland–other airports fare difference before the actual project completion is about 6 percent lower than that after the project has been completed. The effect appears to diminish in size gradually after the actual project completion date, vanishing by the initial target project completion date; we will provide a more formal test for this observation later on.

Reported coefficients on control variables are consistent with our predictions. Specifically, fares for travel to Oakland airport are lower than to other area gateways, confirming the reputation of OAK as the choice airport of the so-called low cost carriers; fares in the first weeks of data collection are also lower than in subsequent ones, predominantly due to the fact that demand for air travel in late spring and early summer happens to be lower than in July and August – traditional peak travel months. One-stop itineraries appear more expensive relative to non-stop ones; however the effect diminishes with distance. The same result can be found in Bilotkach and Pejcinovska (2009).[15] Code-share itineraries are also cheaper relative to those for flights operated by the ticketing carrier – this is consistent with findings of Ito and Lee (2007) for a sample of actual itineraries on the US market. Moreover, our estimate is similar to that of Ito and Lee not only in sign, but also in magnitude. The high R^2s suggest that our specifications fit the data rather well.

Figure 3 graphs estimates (and 95-percent confidence intervals) of the OAK-other airports fare differential, varying the 'before completion' time period from two to nine first weeks of our data collection exercise, as well as including different combination of airline and market level controls (panels (c) correspond to

[15] We have mentioned above that not all the one-stop fare quotes included into our sample represent itineraries that would be likely purchased by actual travelers. We therefore have redone our exercise, discarding the one-stop fare quotes from the airports for which one-stop flights would be an impractical alternative (Phoenix, Las Vegas, Seattle, and Denver). All the results reported in the paper have held (including the robustness checks and the quick dissipation result).

specifications reported in Table 4). This figure basically confirms the results reported in Table 4 and shows that as we expand the period of treatment (limited availability of the freeway) the fare differential declines to the point where it is not statistically different from zero.

[Figure 3 here]

Results reported thus far allow us to state that the freeway interchange collapse had the expected impact on "OAK-other airports" airfare differential, which clearly lasted up to the date of actual reopening of the collapsed bridge segment. Also, the price differential seems to have persisted for some time up to the projected completion date. However, this latter result could be an artifact of aggregating weeks before and after completion which could mask sharp adjustment of price after the freeway re-opening. To remove this aggregation effect, we separated the time period before actual project completion (weeks 1 through 3 of data collection) from that after the actual completion date of May 24 until the target date of June 27 (weeks 4 through 8) and re-estimated our baseline specification. Results presented in Table 5 show that the fare differential was in line with our hypothesized effect during the construction period and then quickly dissipated after reopening of the collapsed freeway interchange. Price adjustment was thus complete and instantaneous. This result holds whether or not we exclude the fare quotes collected in August from consideration.

This important robustness check shows that the price adjustment to pre-collapse levels occurred at the time when the interchange became actually operational (3 weeks after the collapse) rather than when the interchange was scheduled to be reopen (8 to 9 weeks after the collapse). Hence the quickness of the price response cannot be explained by the airlines planning to adjust prices on a particular date and instead it was determined by the actual opening of the interchange. In other words, price adjustment was state dependent rather than time dependent.

[Table 5 here]

In another robustness check, we repeated our data analysis exercise for data collected after June 12. Specifically, we dropped all observations collected during weeks 1 through 6, and split the remaining data into artificial “before-after” intervals, with the “before” interval consisting of three (weeks 7 through 9), six (weeks 7 through 12), and nine (weeks 7 through 15) consecutive dates of data collection. Results of this placebo test (Table 6) suggest that the effect is indeed zero when it is not supposed to exist.

[Table 6 here]

The final issue we need to consider is that of changes in airlines’ capacities. Indeed, a sharp increase in capacity at OAK relative to SFO after the freeway interchange collapse would lead to lower prices at that airport. In general, any exit at SFO and entry at OAK while the freeway interchange remains out would lead us to detect the effect where it does not exist; whereas any entry at SFO and exit at OAK over the same time period would reinforce our conclusion, should we detect the effect we supposed existed.

Using T-100 dataset of the US Department of Transportation, we detected the following entry/exit events from May 2007 (recall the freeway interchange remained out of service for most of this month) to June 2007 on routes covered by our sample (note that total offered capacities have remained flat over the same time period in all three airports – see footnote 1). At Oakland airport, JetBlue Airways added the second daily flight from Boston; Southwest started service from Denver with two daily flights[16]; America West Airlines added a fifth weekday flight from Phoenix; and United Airlines withdrew its daily service from Washington Dulles. At San Francisco International, Alaska Airlines added an eighth daily service from Seattle, while United decreased the number of daily flights from Phoenix from five to four. Of the above discussed events, only United's departure from the Washington-Oakland route and extra flights by Alaska on the Seattle-SFO market could have potential to bias our results in a way which might lead us to conclude the effect was present, while in fact it was not. The only significant entry/exit events in July included further expansion by Southwest on Denver – Oakland market; an extra daily flight by Frontier on Denver – San Jose route; and Frontier Airlines' exit from Las Vegas – San Francisco market.

We employed several strategies to control for the possible bias due to airlines' entry in and exit from certain routes during the time covered by our data collection. First, we controlled for monthly (as available in the T-100 data) frequency of non-stop flights on a given route. Second, we discarded the airline-route combinations for which we observe significant (defined as adding or removing at least one daily non-stop flight) changes in capacity over the time period covered by our data collection exercise. None of these modifications changed our results in any important way.

In summary, our estimates suggest that while the freeway interchange was out of service fare quotes for travel into OAK airport were on average 6-7 percent lower than same for travel into SFO or SJC gateways. We also find that the price differential dissipated quickly and completely after reopening of the freeway.

[16] It was clear from the T-100 dataset that entry occurred on May 31, 2007. In July 2007, Southwest increased its presence on this route to 4-5 daily flights.

4.4 Discussion

At the basic level, it appears that the exogenous shock which led to the change in substitutability between the two airports did affect the corresponding price differential. To assess the plausibility of our results, let us compare the estimated effect to the value of time for a traveler likely to purchase a last minute ticket. Specifically, suppose the freeway interchange collapse did create congestion on the way from San Francisco to Oakland International in such a way that the drive time increased from 32 to 60 minutes, or by almost half an hour (see Table 1). Next, suppose an average last-minute traveler is also an average worker in management occupation, with the average wage of $40/hour (according to the Bureau of Labor Statistics). Then, the value our hypothetical traveler will put on extra half an hour associated with increased congestion is $20 (or $40 if facing the extra congestion on the way both from and to the airport). Although this figure is probably an understatement of the costs faced by the travelers (the costs could be higher due to disutility from spending time in traffic jams, etc.), it is similar in magnitude to $49, which is approximately 7 percent of the average fare into OAK airport in our sample. Thus, the effect we measured is both sizeable and (roughly speaking, of course) not inconsistent with the value of extra travel time for a "probable" last minute traveler. To the extent we can construe our estimate as that of the value of travel time, our estimate of $40 would be probably on the upper end of the distribution of such estimates found in the literature (see Small and Verhoef, 2004; Brownstone and Small, 2005). However, we can easily reconcile our estimate with previous findings by noting that our potential customer is quite likely to earn above average wages.

Our finding that prices almost instantaneously revert to pre-collapse levels provides new evidence on the sensitivity of airfares to shocks. Previous work showed that the airfares are among the least sticky prices. For example, Nakamura and Steinsson (2008) document that the median duration of airfares is about one month while the median duration of price spells across all goods is between 9 and 11 months. We complement this literature by presenting impulse responses of airfares to an exogenous demand shock and showing that airfares exhibit quick adjustment and practically no inertia. The price dynamics is probably best described as an example of state-dependent pricing.

Based on the above information, we can claim that the supply side of the market is likely to have 'fully' absorbed the demand shock (of course, we do not take into account consumer heterogeneity and other factors, so our above thought experiment is only suggestive). We can unfortunately identify our effect only up to the difference between OAK and other airports' fares. Since airlines are known to practice yield management, we can suggest the following mechanisms that could have yielded the result we observed. On the one hand, as demand temporarily switched away from OAK (see Table 2), we could have picked up more discounted fares for travel into this airport. On the other hand, the airlines could have simply raised their high fares for travel into other gateways, keeping OAK fares the same. We cannot conclusively rule out any of these alternatives.

5. Concluding Remarks

This paper studies the sensitivity of prices to demand shocks in a natural experiment that occurred in the San Francisco Bay area in the spring of 2007. Specifically, a freeway interchange collapse after a traffic accident involving a truck loaded with gasoline temporarily cut off an important ground transportation link, thereby also altering the substitutability between the area's major airports. Previous studies and surveys show that the area's gateways (especially the OAK-SFO pair) are indeed treated as substitutes by passengers traveling to San Francisco.

This event, which amounted to both an exogenous demand-side shock for the airlines operating at the area's airports and a significant surface transport infrastructure disruption, temporarily made OAK airport a less attractive choice as compared to SFO for travelers to San Francisco. The purpose of our analysis was to determine how fast and how fully the shock has been absorbed by the supply side, as well as to study the effect of the shock after the shock that caused it disappeared. In addition, our paper examines how a surface road infrastructure disruption affected an industry which crucially depends on this infrastructure. Knowing the exact timing and nature of the shock provides a clean causal interpretation of results in this analysis.

We collected a sample of fare quotes for travel to the three San Francisco Bay area airports via both a leading on-line travel agent and web sites of two major airline companies whose fare quotes were not adequately represented by on-line travel agencies. Importantly, this sample of offered fares is the set of alternatives a hypothetical consumer sees when he or she actually buys a ticket. Our focus was on the last minute fare quotes, as these better reflect actual realization of demand for travel to the area airports. We chose eleven large metropolitan areas (combined, these are home to more than a quarter of U.S. population) for our data collection exercise.

The data analysis revealed that the OAK-other airports fare differential was 6-7 percent lower before reopening of the collapsed freeway interchange as compared to same after the reconstruction work has been completed. The monetary value of this estimate appears consistent with the value of extra travel time a hypothetical business traveler would incur due to additional road congestion following the incident. Thus, we argue that the demand shock was absorbed by the supply side to a substantial degree. Once the demand side shock disappeared, price adjustment to status quo was swift demonstrating that the airfares have practically no price stickiness.

We can draw several general conclusions from our results. First, the market's reaction to the change in substitutability was both swift and in the expected direction; moreover, return to 'normalcy' appeared to be fast as well. Second, it turns out that changes in road congestion can have an almost immediate effect on the markets affected by it. Third, prices appear to be flexible to the extent that airfares adjust within a week in response to shocks.

Our study took advantage of a rather unique event, which both was unanticipated and led to a rather clearly defined temporary change in substitutability between the available alternatives. The results could have been different with less competition on the supply side or in other geographical areas; we have however demonstrated the ability of the supply side to quickly react to, and absorb demand side shocks in a setting that resembles a controlled experiment of the type not commonly encountered in social sciences.

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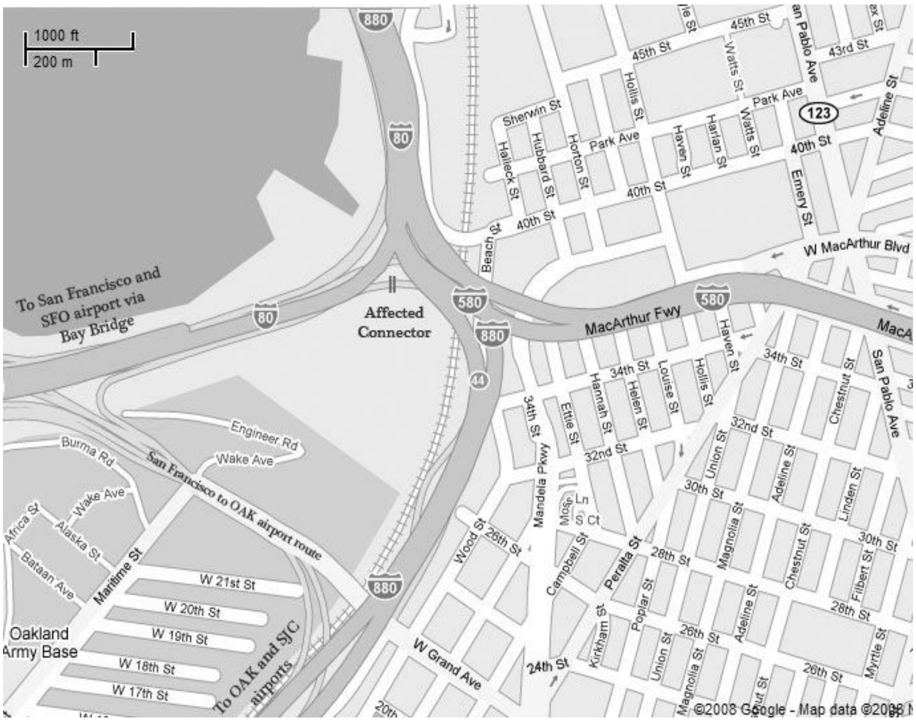
Tables

Table 1 Distances and driving times

		Downtown San Francisco	Downtown Oakland	Downtown San Jose
SFO	Distance (miles)	13.2	22.8	37.8
	Driving time (min)	18	30-50	41-60
OAK	Distance (miles)	21.1	10.0	37.5
	Driving time (min)	32-60	18-25	45-70
SJC	Distance (miles)	46.1	39.7	6.0
	Driving time (min)	51-70	45-70	12

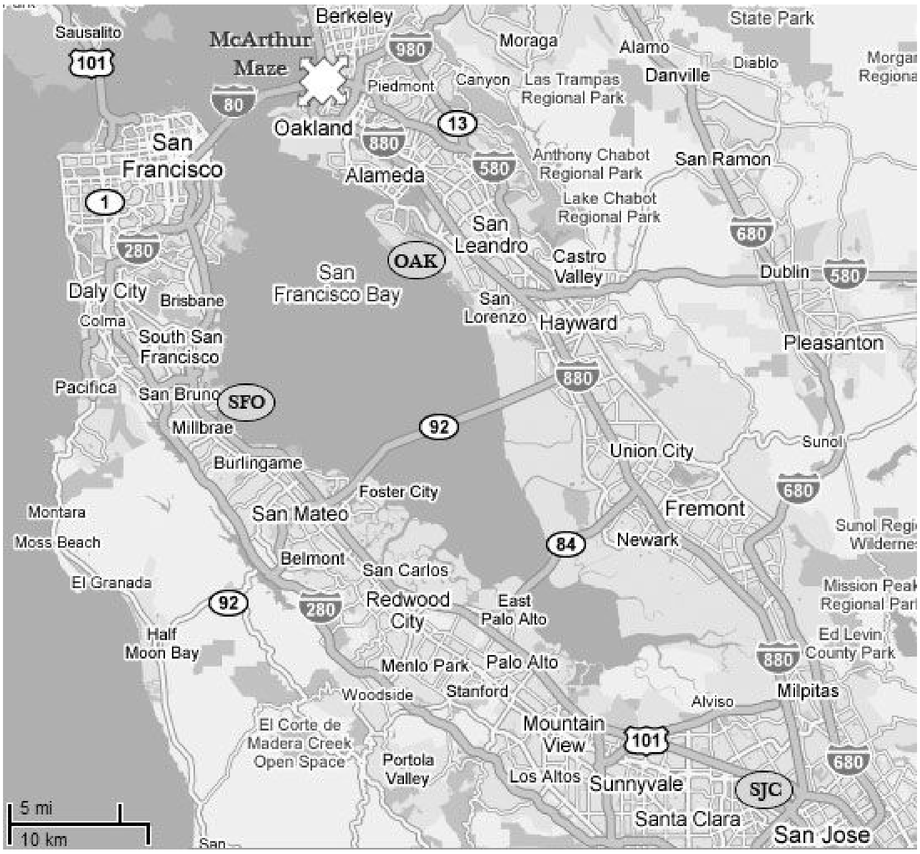
Note: we present driving time as reported by maps.google.com; the upper value in the range represents "driving time in traffic", as reported by the resource.

Figure 1 McArthur Maze and incident location



Source: maps.google.com

Figure 2 McArthur Maze and area airports



Source: maps.google.com

Table 2 Breakdown of traffic across San Francisco area airports in May and June of 2007

	May			June			June – May difference		
	OAK	SFO	SJC	OAK	SFO	SJC	OAK	SFO	SJC
Boston	10.2	80.9	8.8	15.3	76.6	8.0	5.1	-4.4	-0.8
Denver	16.0	58.4	25.6	19.5	55.7	24.8	3.5	-2.8	-0.8
Dallas	17.7	52.5	29.9	18.1	51.3	30.6	0.4	-1.1	0.6
Miami	15.7	84.3	0.0	16.9	83.1	0.0	1.2	-1.2	0.0
Houston	27.6	50.5	21.9	24.8	54.3	20.1	-2.9	3.9	-1.0
Las Vegas	32.4	42.8	24.8	34.6	40.5	24.9	2.1	-2.3	0.2
New York City	10.9	80.6	8.5	10.7	81.2	8.1	-0.2	0.6	-0.4
Chicago	22.9	57.8	19.3	23.1	57.6	19.3	0.2	-0.3	+0.0
Phoenix	35.0	33.3	31.7	36.3	30.5	33.2	1.3	-2.8	1.6
Seattle	32.5	40.1	26.7	33.6	39.2	27.2	1.2	-1.7	0.5
Washington, D.C.	33.8	59.9	6.3	28.8	64.8	6.4	-5.0	4.9	0.1

Notes:

1. Reported numbers are shares (in percent) of passengers traveling non-stop from a given metropolitan area to a given airport in San Francisco area.
2. Calculations performed based on information contained in the T100 dataset.
3. Shares/differences are subject to rounding.
4. See the previous section for a definition of metropolitan areas/airports included.

Table 3 Distribution of fare quotes, by origin metropolitan area

Origin	Mean	S.D.	1st quartile	Median	3rd quartile	Min	Max
Boston	803	211	668	748	784	514	1,658
Chicago	750	213	590	688	868	341	1,614
Denver	776	328	590	638	826	189	1,749
Dallas	799	143	748	782	818	343	1,353
Miami	773	193	668	738	864	399	1,468
Houston	814	119	797	797	811	533	1,277
Washington	859	231	675	821	1,068	394	1,600
New York	782	174	668	738	895	338	1,312
Seattle	449	190	334	371	451	316	1,015
Phoenix	689	386	370	473	837	268	1,761
Las Vegas	471	276	287	306	668	230	1,513

Notes:

1. Values reported are fare quotes net of taxes and fees.
2. On each date of data collection, we recorded the lowest non-stop and one-stop fare quotes by each airline offering those.

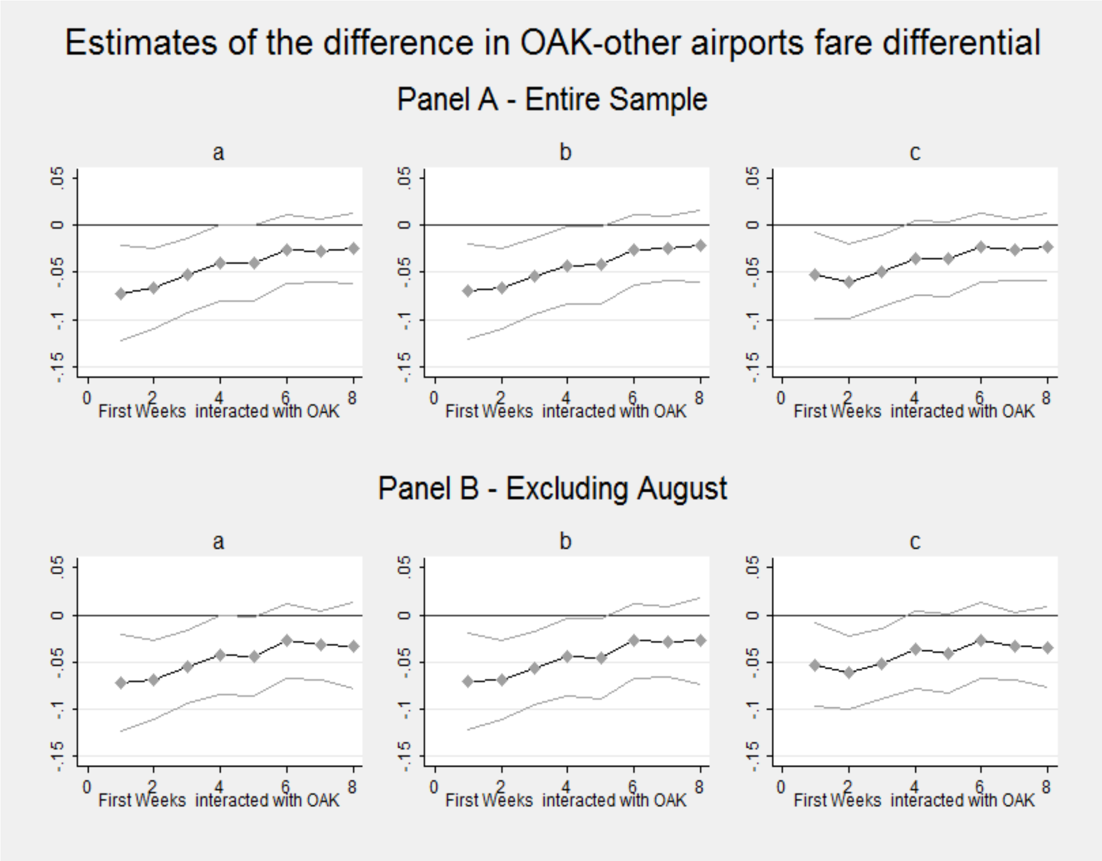
Table 4 Estimation results

Variable	Entire Sample			Excluding August		
	First 3 Weeks	First 6 Weeks	First 9 Weeks	First 3 weeks	First 6 weeks	First 9 weeks
SFO	0.009 (0.019)	0.009 (0.019)	0.009 (0.019)	0.011 (0.020)	0.011 (0.020)	0.011 (0.020)
OAK	-0.029* (0.017)	-0.026*** (0.018)	-0.026** (0.020)	-0.029* (0.017)	-0.023 (0.019)	-0.017 (0.022)
First N Weeks	-0.147*** (0.018)	-0.153*** (0.018)	-0.079*** (0.020)	-0.145*** (0.018)	-0.151*** (0.018)	-0.075*** (0.020)
First N Weeks × OAK	-0.059*** (0.020)	-0.036* (0.020)	-0.022 (0.018)	-0.061*** (0.020)	-0.041* (0.021)	-0.034 (0.022)
One-stop Itineraries	1.609*** (0.403)	1.604*** (0.404)	1.602*** (0.407)	1.515*** (0.402)	1.508*** (0.404)	1.504*** (0.408)
One-stop × Ln(Distance)	-0.221*** (0.055)	-0.221*** (0.055)	-0.220*** (0.055)	-0.208*** (0.055)	-0.207*** (0.055)	-0.207*** (0.056)
Code-share Itineraries	-0.064 (0.053)	-0.064 (0.063)	-0.065 (0.053)	-0.054 (0.052)	-0.053 (0.052)	-0.054 (0.052)
Adjusted R^2	0.719	0.718	0.712	0.729	0.729	0.721

Notes

1. “First N weeks” shows the duration of the assumed treatment period, starting at the time when the interchange collapsed. “First 3 weeks” corresponds to the actual time when the interchange was not available. “First 9 weeks” corresponds approximately to the duration of planned reconstruction of the interchange.
2. The dependent variable is the natural logarithm of fare quote, net of taxes and fees.
3. Number of observations – 3,759; excluding August – 2,819. Excludes top 1 percent of quotes.
4. Corrected for heteroscedasticity using White-robust variance-covariance matrix and intragroup correlation (clustered by airline-destination-origin).
5. Airline, origin metropolitan area, and date of collection effects were controlled for in all regressions.
6. Airline-origin and airline-destination effects were included in all regressions.
7. Statistical significance of coefficients: *** - 1%; ** - 5%; * - 10%.

Figure 3 Estimates of the OAK-other airports effect



Notes:

1. This figure graphs coefficients and 95-percent confidence intervals of the estimate on OAK×BeforeCompletion interaction variable, varying 'before completion' time period artificially from two to nine first weeks of data collection.
2. All specifications control for variables reported in Table 4 and:
    a. Neither airline-origin nor airline-destination effects
    b. Only airline-destination effects
    c. Both airline-origin and airline-destination effects
3. Coefficients on control variables are stable across specifications.

Table 5 Actual versus target project completion

Variables	Entire Sample	Without August
SFO	0.009	0.011
	(0.019)	(0.020)
OAK	-0.026	-0.020
	(0.019)	(0.019)
Weeks 1-3	-0.145***	-0.036*
(before actual completion)	(0.022)	(0.019)
Weeks 4-8	0.003	0.112***
(after actual, before planned)	(0.021)	(0.019)
(Weeks 1-3) × OAK	-0.062***	-0.070***
	(0.023)	(0.024)
(Weeks 4-8) × OAK	-0.008	-0.016
	(0.016)	(0.017)
One-stop Itineraries	1.609***	1.516***
	(0.403)	(0.403)
One-stop × ln(Distance)	-0.221***	-0.208***
	(0.055)	(0.055)
Code-share Itineraries	-0.064	-0.054
	(0.053)	(0.052)
Number of observations	3,759	2,819
Adjusted R^2	0.719	0.729

Notes:

1. Dependent variable is natural logarithm of fare quote, net of taxes and fees.
2. Excludes upper 1 percent of quotes.
3. Corrected for heteroscedasticity using White-robust variance-covariance matrix and intragroup correlation (clustered by airline-destination-origin).
4. Airline, origin metropolitan area, and date of collection effects were controlled for in all regressions.
5. Airline-origin and airline-destination effects were included in all regressions.
6. Statistical significance of coefficients: *** - 1%; ** - 5%; * - 10%.

Table 6 Regression results excluding first six weeks of data collection

	Weeks 7-9	Weeks 7-12	Weeks 7-15
SFO	0.012	0.012	0.012
	(0.022)	(0.022)	(0.022)
OAK	-0.021*	-0.032	-0.017
	(0.019)	(0.021)	(0.028)
Weeks	0.001	0.119***	0.128***
	(0.022)	(0.019)	(0.019)
Weeks × OAK	-0.002	0.023	-0.005
	(0.021)	(0.017)	(0.022)
One-stop Itineraries	1.696***	1.693***	1.696***
	(0.473)	(0.474)	(0.473)
One-stop × ln(Distance)	-0.232***	-0.232***	-0.232***
	(0.063)	(0.063)	(0.063)
Code-share Itineraries	-0.040	-0.041	-0.040
	(0.064)	(0.065)	(0.064)
Adjusted R^2	0.720	0.720	0.720

Notes:

1. The dependent variable is the natural logarithm of fare quote, net of taxes and fees.
2. Number of observations – 2,309.
3. Corrected for heteroscedasticity using White-robust variance-covariance matrix and intragroup correlation (clustered by airline-destination-origin).
4. Airline, origin metropolitan area, and date of collection effects were controlled for in all regressions.
5. Airline-origin and airline-destination effects were included in all regressions.
6. Statistical significance of coefficients: *** - 1%; ** - 5%; * - 10%.

Appendix

Table A.1 Timeline of data collection and freeway interchange reconstruction project

Week #	Data Collection	Flight Date	Return Flight Date	Project Milestones/Notes
April 29, 2007 – a tanker truck incident leads to the freeway interchange collapse				
1	May 8	May 9	May 11	
2	May 15	May 16	May 18	
3	May 22	May 23	May 25	Interchange was reopened on the evening of May 24
4	May 29	May 30	June 1	
5	June 5	June 6	June 8	
6	June 12	June 13	June 15	
7	June 19	June 20	June 22	
8	June 26	June 27	June 29	June 27 was the target project completion date
9	July 3	July 4	July 6	
10	July 10	July 11	July 13	
11	July 17	July 19	July 21	
12	July 24	July 25	July 27	
13	July 31	August 1	August 3	
14	August 7	August 8	August 10	
15	August 14	August 15	August 17	
16	August 21	August 22	August 23	

Table A.2 Distribution of fare quotes, by market

Origin	Destination	Mean	S.D.	1st quartile	Median	3rd quartile	Min	Max
Boston	SFO	848	238	738	748	798	573	1,658
	OAK	762	178	668	718	773	548	1,378
	SJC	773	181	668	738	786	514	1,318
Chicago	SFO	850	207	708	840	878	538	1,614
	OAK	679	201	590	610	749	341	1,482
	SJC	740	199	590	678	803	421	1,358
Denver	SFO	650	193	575	595	698	189	1,492
	OAK	748	275	584	649	850	471	1,431
	SJC	895	404	600	651	1,288	550	1,749
Dallas	SFO	794	146	778	782	788	343	1,353
	OAK	758	125	658	682	828	455	1,090
	SJC	842	143	778	788	973	529	1,248
Miami	SFO	710	161	643	703	768	410	1,212
	OAK	779	205	642	738	864	399	1,468
	SJC	842	194	678	752	994	576	1,418
Houston	SFO	815	107	797	797	807	609	1,277
	OAK	829	115	797	798	853	678	1,158
	SJC	801	130	678	798	847	533	1,132
Washington	SFO	985	233	797	997	1,193	394	1,600
	OAK	738	194	598	678	878	486	1,138
	SJC	855	199	678	822	1,043	504	1,303
New York	SFO	799	181	668	728	923	493	1,312
	OAK	774	134	668	718	811	627	1,122
	SJC	761	191	668	748	877	338	1,193
Seattle	SFO	522	250	371	383	534	352	1,015
	OAK	432	142	334	362	458	328	802
	SJC	398	139	328	334	397	316	803
Phoenix	SFO	630	358	401	416	872	268	1,404
	OAK	618	312	369	387	821	280	1,495
	SJC	788	439	370	815	853	322	1,761
Las Vegas	SFO	402	179	278	300	480	258	919
	OAK	523	340	287	298	680	248	1,513
	SJC	467	244	297	367	668	230	1,503

Notes:

1. Values reported are fare quotes net of taxes and fees.
2. On each date of data collection, we recorded lowest non-stop and one-stop fare quotes by each airline offering those.

Table A.3 Differences in average fare quotes across markets

Origin	SFO-OAK			SFO-SJC			OAK-SJC		
	3 weeks	6 weeks	9 weeks	3 weeks	6 weeks	9 weeks	3 weeks	6 weeks	9 weeks
Boston	285.3	109.9	54.4***	206.4	97.3	67.0**	-78.9	-12.7	12.6
Chicago	120.8*	189.7**	177.7***	82.3	65.6	240.3***	-38.5	-124.1	62.6**
Denver	-148.6	-198.7	-79.4	-306.4	-343.5	-302.2	-157.9	-144.8	-222.8
Dallas	4.6	50.8	119.5	-95.8	-73.6*	11.1	-100.5	-124.5*	-108.4*
Miami	-11.9	-46.5	-61.9	-92.8	-80.4	-63.9	-80.8	-33.9	-2.06
Houston	16.5	-58.4	0.4	37.8	-48.5	58.2	21.3	9.9	57.8
Washington	302.9**	343.3**	214.5	128.9	214.9*	148.6	-174.0*	-128.4	-65.9
New York	62.1	-25.5	2.1	61.4	-71.4	47.7	-0.7	-45.9	45.6
Seattle	-14.0	156.6	195.1	56.7	251.9**	217.1	70.7	95.3	22.0
Phoenix	-104.9	-79.0	8.9	-310.3	-203.8	-115.9	-205.4	-124.8	-124.8
Las Vegas	69.8	35.6	-75.9	-43.0	-42.3	-201.7	-112.8	-77.8	-125.8

Notes:

1. Values reported here are differences in mean fare quotes for travel from a metropolitan area to corresponding airports in the San Francisco Bay area.
2. Fare quotes were averaged across first three (ending right before actual reopening of the interchange), first six (after reopening but before target completion date), and first nine (ending after the target completion date) weeks of data collection.
3. Statistical significance of differences from zero: *** - 1%; ** - 5%; * - 10%.