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The determinants of pricing in the Mexican domestic airline sector and the impact of competition and airport congestion

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Abstract: This paper estimates econometric models to examine the main determinants of pricing in the Mexican domestic airline sector. Average fares are approximately 30 percent lower on routes where at least one low-cost carrier is present. Fares on routes into or out of the Mexico City Airport, the only "congested" airport, are between 40 and 80 percent higher, controlling for airport fees. This suggests that the societal costs of airport congestion can go well beyond the negative congestion externality and should also include the effects of reduced competition from high entry barriers and lack of potential competition. The evidence on the effect of hub and spoke competition is mixed while codesharing is found to result in higher prices. Based upon these estimates there are large consumer benefits from implementing sound competition policy and market-based mechanisms to alleviate airport congestion.

Classification JEL: L40, L93, R41.

Key Words: Airlines, airport, competition, congestion, low-cost carriers.

I. Introduction

The presence of low-cost airline carriers on a route has been found to be associated with lower airline fares. Morrison (2001) found that in 1998 the low-cost carrier Southwest airlines was responsible for $12.9 billion in consumer savings, approximately 20 percent of the industry's 1998 domestic scheduled passenger revenue. Bennet and Craun (1993) found that average fares were approximately 50 percent lower in markets served by Southwest airlines. Daraban and

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This work evolved from the OECD-Mexico Competition Assessment Toolkit project between the OECD and the Mexican Competition Commission. The opinions expressed and arguments employed herein do not necessarily reflect the official views of the OECD or of the governments of its member countries, nor the Mexican Competition Commission. I thank members of the Technical Committee of the project for their many insights and suggestions. I also thank Douglas Umana for his excellent assistance in data gathering and Craig Conrath, Sean Ennis, and Ernesto Estrada for their many insights and suggestions. I especially thank Severin Borenstien, Jose Gomez Ibanez, Steve Morrison and William E. Taylor their review and significant contributions to the analysis. All errors are my responsibility.

Fournier (2008) found that incumbents dropped fares by a total of 22 percent prior to and after entry by Southwest, a finding consistent with Goolsbee and Syverson (2008).

Congestion at airports has been found to impose significant costs on consumers. Daniel and Harback (2009) found that implementing congestion pricing at 27 major US airports would reduce delays by 13 passenger years and 1000 aircraft-hours each day, saving 3-5 million dollars daily. Other studies have also examined the impact of airport congestion on welfare, Morrison (1983) and Morrison and Winston (1989). These studies, however, have not examined the impact that airport congestion can have on competition and on airline fares. Abramowitz and Brown (1993) examine price determinants in the US airline industry controlling for the effects of congestion, as measured by the takeoffs and landing per runway at the two endpoints, and find that congestion is associated with higher fares.

Borenstein (1989) examined the issue of airport dominance and the hub premium and found higher fares associated with airlines' hub, indicating that carriers exercise some market power over their hubs. Subsequent research generally confirms these finding, Berry (1990), Evans and Kessides (1993) and Berry, Carnall and Spiller (2005). There is a large literature on the impact of codesharing on fares including Brueckner (2003) and Brueckner and Whalen (2000) focusing on the impacts of international alliances and codesharing while Armantier and Richard (2006) and Ito and Lee (2006) focus on domestic codesharing, with mixed results.

The purpose of this paper is to extend the literature by examining the impact on domestic airfares in Mexico of: low-cost carrier entry, airport congestion at the Mexico City airport, competition between the two incumbent hub-and-spoke airlines and codesharing. Using a new dataset of domestic airline prices in Mexico collected in 2009, this paper finds that average prices per kilometer are approximately 30 percent lower on those routes where a low-cost carrier is present. Average prices at the Mexico City Airport, the only airport in Mexico that has been officially designated as operating under "saturation" conditions, are between 40 and 80 percent higher, controlling for airport charges for takeoff/landing, platform and security services.[2] The results on the impact of competition between the two incumbent operators that operate hub-and-spoke are mixed while the presence of codesharing between Mexican and Aeromar results in higher fares.

Section II provides a summary of the liberalization process in Mexico and a review of market structure. Section III describes the data used for this study and provides some summary statistics. Section IV presents the econometric models and Section V presents conclusions and policy recommendations.

II. Liberalization and Market Structure

The airline sector in Mexico has had a long history of government involvement and participation. The two principal airlines in Mexico are Aeromexico and Mexicana. Although these airlines started out as private enterprises (Mexicana in 1921 and Aeromexico in 1934) by the early 1980s the government owned majority shares in both. The companies were privatized in the late 1980s and served approximately 90 percent of the market. Entry into the sector was regulated by the government through the issuing of concessions and permits to provide air service. That process, however, was neither transparent nor predictable, and obtaining a concession to enter and compete against the two incumbent carriers was not easy. In August 1991 the government eased its

[2] When an airport is saturated, like Mexico City, it means that the number of airlines using take-off and landing slots is at a maximum during certain times of the day and no further flights can take off or land. When this occurs the SCT is empowered to implement reforms to alleviate the levels of congestion.

restrictions on entry which led to the creation of new airlines that competed against Aeromexico and Mexicana.[3]

By 1995 Aeromexico and Mexicana were in difficult financial conditions due to increased competition and the financial crisis that affected Mexico in that year. These circumstances forced the government once again to take majority control of both companies, a situation that would last more than ten years until the privatization of Mexicana in 2005 and Aeromexico in 2007. During this period, competition between Aeromexico and Mexicana was not very intense, even though the government imposed certain requirements that were intended to maintain independent managerial and operating structures and limit the firms' exercise of market power.[4]

In the mid 2000s, the period coinciding with the privatization of Mexicana and Aeromexico, the industry experienced an important development, the entry of the low-cost carriers. Carriers such as Interjet, Vivaaerobus and Volaris entered the market in the period 2004-2006 and have established themselves as important competitors. Other carriers following the low-cost carrier option — such as Alma and Avolar — also entered the market but have since exited.

A competition analysis of the domestic airline sector in Mexico — based upon publicly-available data from the Secretariat of Communications and Transport ("SCT" (2008)) — leads to several conclusions about the sector's performance and level of competition. The sector experienced

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[3] Comision Federal de Competencia, "Caso Cintra," available at http://www.cfc.gob.mx/images/stories/comunicacion/Publicaciones/DOCUMENTO%20CASO%20CINTRA.pdf, (*Cintra Case*).

[4] Some of the requirements of the Commission were more regulatory in nature, while others were more geared toward improving competition. With respect to the former, tariffs were to be related to price-cost margins and to be benchmarked to similar carriers in other countries. With respect to the latter, administrative impediments to entering the markets were removed and the Commission monitored certain practices that could raise competitive concerns, such as travel agent commissions and codesharing.

fairly robust growth during the period for which data are available, 1989-2008. The compound annual growth rate for total domestic passengers between 1989 and 2008 was approximately 5.40 percent a period during which Mexico's real GDP growth was approximately rate 3.0 percent. There has been a significant decrease in concentration during the same period with strong recent gains made by the three low-cost carriers. In 1989 the Herfindalh-Hirshman Index ("HHI")—based upon a nationwide market—was 4396 and by 2008 the figure had decreased to 1766.[5] Five low-cost carriers entered the market in 2005-2006 and by the end of 2008 the three low-cost carriers that remained in the market had captured more than 30 percent of passenger traffic. There is little publicly-available information on profitability. The evidence that exists indicates low levels of profitability for the two incumbent operators since the mid 2000s.[6] And, since 2007 four airlines have exited the market. With respect to pricing, the government does not publish time-series data on airline prices in Mexico. Based upon two analyses of 12 domestic routes conducted by a Mexican think tank — one in 2000 and one in 2008 — airline prices decreased by approximately 4 percent per year during those two time periods, aregional.com (2008). Based upon the study of airline prices in this paper, however, prices on those same routes were close to 20 percent higher in 2009 compared to 2008.[7]

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[5] Author's calculation based upon data in SCT (2008).

[6] See World Airline Reports 2005-2008, available at http://www.atwonline.com.

[7] Obtaining airline prices requires a standard methodology in order to compare results across time. In this study, the lowest price, round-trip fares with all taxes and surcharges included were selected. For some routes, the departure date was less than a week while for other routes it was more than two weeks with a Saturday night stay over. The aregional.com report does not detail the methodology they used to collect prices for these routes. Caution is therefore urged in comparing the results and reaching conclusions.

III. Data & Summary Statistics

The SCT provides passenger information by route — monthly and yearly passengers travelled and total flights — for approximately 600 point-to-point routes in Mexico in 2008, SCT (2008).[8] The 600 routes roughly equal the population of routes in Mexico. Data were obtained for approximately 500 of these routes.[9] Price data for the different airlines were collected during the period April through August 2009.[10]

The total number of airlines offering service in Mexico was identified based upon information provided by the SCT in 2008.[11] The SCT identifies trunk and regional carriers. Trunk carriers tend to fly larger aircraft and provide service throughout Mexico while regional carriers tend to fly smaller aircraft and provide air travel within discrete geographical areas of Mexico. In 2008 the SCT data show a total of 13 airlines (both regional and trunk) providing domestic service in Mexico. Of the 13 airlines, three ceased operating sometime in 2008 (these airlines were Aerocalifornia, Alma, and Avolar). This left 10 airlines for data analysis. In 2008 the SCT data shows only four regional airlines, a number that is significantly lower than in earlier years. Of the four airlines, however, two are owned by the two large incumbent trunk airlines, Aeromexico and Mexicana. Aeromexico operates Aeroliteral (Aeromexico Connect) while Mexican operates

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[8] The total number of routes was 589.

[9] Specifically, we collected data on 497 routes. The difference between the 589 routes identified in 2008 and the 497 routes we collected can be explained, in part, by seasonality—some of the 589 routes are not flown during the months we collected our data—and by the possibility that some of the routes are no longer provided. A review of the data show that these missing routes where proportionally lower demand routes than the average route for which we did obtain information. The mean for these routes was 159 flights per year compared to the mean of 887 flights per year for our data.

[10] This time period is very atypical for the Mexican economy and the airline sector in Mexico. Mexico was hit very hard by the U.S. recession in 2008-2009. And the H1N1 virus epidemic was first reported in Mexico in late April 2009 and subsequently caused a severe contraction in travel to, from and within Mexico.

[11] See footnote 8.

Aerovias Caribe (Click). These two regional carriers provided service to more than 85 percent of the passengers flying on regional routes as determined by the SCT. The data analysis below did not distinguish between the incumbent operators—Aeromexico and Mexicana—and their respective regional subsidiaries—Connect and Click, respectively.[12] Thus 8 airlines were left for data analysis when data collection commenced.[13]

For each route identified by the SCT the web sites of each of the airlines were consulted to determine whether the airline provided service on the route.[14] A departure and return date was selected and a price quote for those dates for *each* airline that offered service on the route was obtained. That is, generally the same departure and return dates were used for the price quotes for each airline that provided service on the route. If the airline offered service for that route, a price quote was obtained from the airline's website for the lowest quoted round-trip service.[15] For each airline that provided service on the route an attempt was made to obtain price quotes for the same departing/returning dates for all carriers. When this was not the case the difference in date was generally within plus or minus one calendar day. This occurred in less than 10 percent of the observations. Thus, for each route there is a price quote for each airline providing service on the

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[12] Aeromexico and Mexicana did not have separate web sites for their respective subsidiaries and it was not always clear for a given route whether the flight would be provided by the subsidiary. Therefore, average prices in this study for Aeromexico and Mexicana represent average prices for all flights offered by these airlines including flights offered by their respective subsidiaries.

[13] This number was further refined during our data collection process because one airline, Aviacsa, ceased providing passenger service shortly after data collection began. The airline was shut down by the government for a number of reasons, and although in press statements the airline expects to provide service again as of the end of our data collection it had not resumed service.

[14] All the airlines had a functioning website that allowed customers to search different itineraries and make reservations.

[15] Prices included all applicable taxes. Where a carrier offered only one-way flights the data were not collected—this was the case for some Interjet and Volaris observations.

route and an *unweighted* lowest available average fare across all carriers serving the route was calculated and was used as the dependent variable in the study.

Some additional comments about the dependent price variable are in order. First, the departure and return date were used to create dummy variables for each route (and thus each observation) that indicated whether prices were discriminating between business and leisure travelers. If the departure and return date were taken 2-3 weeks in advance *and* required a Saturday night stay, the price quote was considered as one for a leisure passenger. Since price quotes were collected from each airline for the same departure and return date, each observation has a dummy variable ("leisure") indicating whether the departure date for the route was greater than two weeks and required a Saturday night stay.[16] Another dummy variable ("non-leisure") measured whether the departure date was less than 7 days in advance and did not require a Saturday night sleep-over.[17] The choice in the departure and return date, and thus whether the route is considered a leisure or non-leisure route, was random.

Second, when an option between a non-stop and one-stop flight was given on an airline site the former option was selected as long as the prices were the same. If they were not the same then the lowest price option was selected.[18]

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[16] Unfortunately we did not begin collecting whether the departure and return dates were 2-3 weeks in advance and required a Saturday night stay for the first 60 route observations. This explains why the leisure variable has 437 observations while the other variables have 497 observations.

[17] We did collect this information for all the routes in our sample and thus have 497 observations for this variable.

[18] Flights with 2 stops were not considered even though they might have presented a cheaper alternative (this was seldom the case with Mexicana). The reason for this was the unlikely preference of a customer to travel within Mexico with 2 stops (some flights like this lasted several hours) and the substantial reduction in the average price that this choice entailed.

Third, the route A-B-A is considered a different route than B-A-B. For example, one observation was for the route Mexico City to Cancun to Mexico City and another observation was for the route Cancun to Mexico City to Cancun. We found that prices on these routes were somewhat different.[19]

Table 1 below presents the variable names and data sources used in the study as well as a description of the variable and, where necessary, how the variable was created. Some of the variables are proxies attempting to measure unobservable characteristics. For example, the leisure and non-leisure variables attempt to measure a customers' willingness to pay by how far in advance from departure the price quote was obtained and whether a Saturday night stay was required. The tourist destination variable (touristdest) was obtained by consulting a Mexican tourist industry website that highlights tourist destinations in Mexico and by engaging in research to determine whether the destination was more geared toward tourists or business people. The airport saturation variable measures whether the origin or destination airport is operating under conditions of saturation, as determined by the SCT. Mexico City is the only airport operating under such conditions, thus the saturation variable captures the effects of flying into or out of Mexico City.

[19] This could be due to airlines charging different fares for these routes, *i.e.*, charging different prices for roundtrips from Mexico to Acapulco and Acapulco to Mexico. It could also be due to the fact that airline prices for this study were collected over a 4-5 month period.

TABLE 1
VARIABLES USED IN STUDY

Variable Name	Variable Description	Source
Price	Average roundtrip price per route in Mx pesos per kilometer for all airlines offering service	Respective airlines'websites
Distance	Distance in kilometres of non-stop roundtrip travel between origin and destination	www.world-airpot-codes.com
pass08	Number of passengers in 2008 for the month the data were collected (in 000)	SCT
gdp07	2007 nominal GDP per capita of the origin city in Mx pesos (in 000)	INEGI & CONAPO
Nonleisure	Dummy variable, 1 if data collected less than 1 week before departure,	N/A
Leisure	Dummy variable, 1 if data collected more than 2 weeks in advance and requires a Saturday night stay	N/A
Touristdest	Dummy variable, 1 if destination is a tourist destination,	Consejo de Promocion Turistica, http://www.cptm.com.mx/index.jsp, and own research
Airportsat (Mexico City)	Dummy variable, 1 if destination or origin airport is "saturated;" only Mexico City is saturated	Own research
Airportcost	The average of the two (origin & destination) airport charges in pesos in 2007 covering the cost of using the airport, takeoff/landing fees, platform and security costs	Comision Federal de Competencia
Ncomp	Number of airlines offering service on the route	Own research
Nlcc	Number of "low-cost" carriers offering service on the route	Own research
Lcc	Dummy variable, 1 if a low-cost carrier offers service on the route	Own research
incumbentcomp	Dummy variable, 1 if there is competition between the two incumbent airlines, Aeromexico and Mexicana on the route	N/A
cdshmexmar	Dummy variable, 1 if there is code sharing between Mexicana and Aeromar on the route	Own research

A list of the total number of possible competitors nationwide was obtained from the SCT and this list was used to determine whether the airline offered service on the route in question. The independent variable ncomp, measures the total number of competitors providing service on the route. Three competitors were identified as being low-cost competitors, these were Intejet, Vivaaerobus, and Volaris and this was used to create the dummy variable, lcc, indicating the presence of a low-cost carrier on the route and the variable nlcc, indicating the total number of low-cost carriers on the route.

Table 2 below presents the descriptive statistics for the variables used in the study.

TABLE 2
DESCRIPTIVE STATISTICS

Variable Name	Obs	Mean	Std. Dev.	Min	Max
Price	497	2.87	2.09	0.64	14.29
Distance	497	916	611	58	3,233
distance (lcc)(1)	207	1125	635	214	3233
distance (non-lcc)(2)	290	768	549	58	3171
pass08	497	4.84	10.55	0	90.29
pass08tot	497	54.29	121.39	0	1,047.73
gdp07	497	120.96	86.80	41.94	776.943
Nonleisure	497	0.47	0.50	0	1
leisure(3)	437	0.54	0.50	0	1
Touristdest	497	0.25	0.43	0	1
Airportsat (Mexico City)	497	0.20	0.40	0	1
Airportcost	491	1666.92	132.41	1375	1939
Ncomp	497	2.20	1.14	1	7
Nlcc	497	0.55	0.76	0	3
Lcc	497	0.42	0.49	0	1
Incumbentcomp	497	0.48	0.50	0	1
Cdshmexmar	465	0.19	0.39	0	1
load08	61	0.63	0.12	0.27	0.90

(1) Average distance flown by low-cost carriers; (2) Averge distance flown by non-low-cost carriers; (3) There are only 437 observations for the leisure variable because we did not track this for the first 60 observations collected.

Some of the more interesting findings are those on mean prices, number of competitors (ncomp) per route, number of low-cost competitors (nlcc) per route—and the presence of at least one low-cost competitor (lcc) per route—whether the two main incumbent carriers compete (incumbentcomp) and whether the destination or origin airport is saturated (airportsat).The data show mean airline prices are $2.86 Mx peso/kilometer[20] and that the mean number of competitors on the average route in Mexico is 2.2.[21] The mean value of the number of low-cost competitors on a route is 0.55 and a low-cost competitor was present on 42 percent of the routes analyzed. Competition between the two incumbent carriers, Aeromexico and Mexicana, occurred on 48 percent of the routes and 20 percent of the routes involved the Mexico City airport, the airport that was saturated as defined by the Secretariat of Communications and Transport. Approximately 25 percent of the flights were to tourist destinations.

Table 3 below presents summary price statistics by airline and by type of airline, *i.e.*, whether the airline is a low-cost airline or whether it is an incumbent airline. The three low-cost airlines are Interjet, Vivaaerobus and Volaris while the "traditional" carriers are Aeromexico, Mexicana, Aeromar, Aviacsa and Magnicharters. Low-cost carriers' prices per kilometer are significantly lower than the prices per kilometer of the traditional carriers, although as the table reveals low-cost carriers tend to fly longer routes. Each low-cost carrier's mean price is well below the prices

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[20] Applying an exchange rate of 13 Mx pesos per US$ and converting kilometers to miles, we obtain a figure of approximately $US 0.37/mile. According to Steve Morrison and Cliffor Winston, in 2007 U.S. revenue per passenger mile was approximately $US 0.13/mile, see "Competition in the Airline Industry," Hearing Before the Judiciary Committee Antitrust Taskforce United States House of Representatives, April 24, 2008, Statement of Steven A. Morrison and Clifford Winston, "The State of Airline Competition and Prospective Mergers." Thus, average airline prices in Mexico in 2009 were almost three times higher than average airline prices in the U.S. in 2007. Of course demand and cost characteristics, including average route distances and the level of competition, in the U.S. and in Mexico vary greatly and can help explain the difference.

[21] Morrison and Winston, *op cit 20,* found the average number of effective competitors per route in the U.S. in 2007 to be approximately 2.3.

of the traditional carriers.[22] The average price of the incumbent carriers is 3.05 pesos per kilometer compared to 1.78 pesos per kilometer for low-cost carriers, a statistically significant different of approximately 42%. The prices of the two largest traditional airlines, Aeromexico and Mexicana, are almost identical. The airline with the highest price is Aeromar, a traditional carrier, while the airline with the lowest fares is Vivaerobus, a low-cost carrier.

TABLE 3
DESCRIPTIVE PRICE STATISTICS BY AIRLINE AND TYPE OF CARRIER

Airline	Obs	Average distance/route	Mean	Std. Dev.	Min	Max
"Traditional" Carriers						
Aeromexico	354	964	2.88	1.90	0.75	15.41
Mexicana	347	866	2.98	1.37	0.95	15.24
Aeromar	97	677	5.15	3.09	1.25	14.36
Aviacsar	10	869	2.90	1.37	0.95	5.20
Magnicharter	13	803	2.45	0.97	1.46	4.40
Average	465		**3.05**			
"Low-cost"Carriers						
Interjet	145	977	2.01	0.91	0.90	4.70
Vivaaerobus	46	934	1.32	0.45	0.71	2.72
Volaris	82	1496	1.39	0.44	0.70	2.99
Average	207		**1.78***			

*Significant at the 1% level.

Table 4 below presents descriptive price information summarized by the number of low-cost carriers on a route. Price is the average price for all airlines (both low-cost and traditional) that

[22] As shown in Table 2, however, the low-cost carriers' average distance traveled is significantly greater than the average distance traveled by the traditional carriers, which results in lower prices/km for the low-cost carriers. Thus care should be used in interpreting these results. The econometric estimates control for distance, as well as other variables, when comparing low-cost carrier to non-low-cost carrier fares.

offer service on the route in question. For example, the mean price on a route when no low-cost carriers were present was 3.44. This compares to 2.17, when there was one low-cost carrier (a difference of approximately 37%) 1.79 when there were two low-cost carriers (a difference of approximately 48%) and 1.61 when there were three low-cost carriers (a difference of approximately 53%). These differences compared to 0 low-cost carriers are all statistically significant at the 1% level. The average price when there was at least one low-cost carrier was 2.06, a difference of approximately 40% and also statistically different than 3.44 at the 1 % level. These results provide evidence that mean airline prices in Mexico tend to be significantly lower on those routes where low-cost carriers operate.

TABLE 4
DESCRIPTIVE PRICE STATISTICS BY "LOW-COST" CARRIERS

"Low-cost"Carrier	Obs	Mean	Std. Dev.	Min	Max
0 LCC	290	3.44	2.46	0.64	14.29
1 LCC	157	2.17*	1.08	0.81	5.36
2 LCC	34	1.79*	0.49	0.91	2.98
3 LCC	16	1.61*	0.48	0.95	2.60
At least 1 LCC	207	2.06*	0.99	0.81	5.36

*Less than the mean of 0 LCC at 1% level of stastistical significance.

Table 5 below presents descriptive price statistics summarized by the number of competitors on a route and whether there was a low-cost carrier competing on the route. For example, the first row indicates that the mean price on a route with only one competitor was 2.74. The mean price, however, was 1.90 on routes where there was only one competitor and that one competitor was a low-cost carrier, a difference of approximately 30% and significant at the 2.5% level. The same is the case for routes with two and three competitors. The mean price on routes with two competitors was 3.06, but when at least one of the two competitors was a low-cost carrier, the mean price decreased to 2.03, a difference of approximately 34%. For three competitors comparable numbers are 3.20 and 2.10, a difference of approximately 34%. Interestingly, mean prices tend to increase as the number of competitors increase from one to three, after which mean prices decrease. This is something that is discussed further in the econometric section of the paper.

TABLE 5
DESCRIPTIVE PRICE STATISTICS BY "LOW-COST" CARRIERS & NUMBER OF COMPETITORS

Number of Competitors	Price	Std. Dev.	Number of Competitors & at least 1 LCC	Price	Std. Dev.
1	2.74	1.95	1	1.90**	1.18
2	3.06	2.29	2	2.03*	0.86
3	3.20	2.35	3	2.10*	1.00
4	2.22	1.03	4	2.18	1.07
5	2.03	0.97	5	2.03	0.97
6	1.74	0.40	6	1.74	0.40
7	1.48	-	7	1.48	-

*Statistically significant at the 1.0% level of significance, ** at 2.5% level of significance

Finally, Table 6 below presents descriptive price statistics summarized by whether there is competition on a route between the two incumbent operators, Aeromexico and Mexicana, and whether either the origin or destination airport is operating under conditions of "saturation" which means it is difficult for competitors to obtain slots to operate flights. As mentioned, Mexico City is the only airport that is saturated so the variable measures the average difference in airline prices in Mexico City compared to all other airports in Mexico. Mean prices on routes where Aeromexico and Mexicana compete with each other are approximately 3.8% lower than mean prices on routes where they do not compete. The difference, however, is not statistically significant. With respect to Mexico City prices, mean prices are significantly higher flying into or out of Mexico City. The mean price on routes to and from Mexico City is 3.89 compared to 2.61 for other airports, a difference of approximately 33% and statistically significant at the 1% confidence level. As discussed further below, since Mexico City's airport is saturated, this condition is having an impact on Mexico City prices for a number of reasons, including the lack of potential competition and high entry barriers.

TABLE 6
DESCRIPTIVE PRICE STATISTICS BY INCUMBENT COMPETITION & AIRPORT SATURATION (MEXICO CITY)

	Obs	Mean	Std. Dev.	Min	Max
Incumbent competition present	237	2.81	1.88	0.82	12.46
Incumbent competition not present	260	2.92	2.27	0.64	14.29
Airport not saturated	397	2.61	1.72	0.64	12.27
Airport saturated (Mexico City)	100	3.89*	2.96	1.16	14.29

*Statistically significant at the 1% confidence level

IV. Econometric Model

In this section, econometric models are estimated to determine whether the price relationships presented above hold when other determinants of price are formally held constant. Parameters are estimated using ordinary least squares (OLS) and instrumental variables (IV) to account for the possible endogeneity in some of the explanatory variables. There are observations on close to 500 domestic point-to-point routes in Mexico and there are data on, *inter alia*, average prices per route, distance per route, previous years' passengers and flights flown per route, income of origin city, whether destination city is a tourist attraction, the number of competitors and low-cost competitors per route, whether the origin or destination airport is Mexico City, the average of the two (origin & destination) airport charges in pesos in 2007 covering the cost of using the airport, takeoff/landing fees, platform and security costs, etc, and whether the two main incumbents compete on the route. Several models are estimated to examine and quantify the main determinants of average prices per route. Specifically, the following general model is estimated:

(1) $$\mathbf{Y} = \mathbf{X}\beta + \mathbf{u}$$

where **Y**, the dependent variable, is the average price per route, **X** is an N x k matrix of sample values of the independent variables, β are the k parameters to be estimated and **u** is the stochastic disturbance with the assumption that E [**u** | x] = 0, which means that the unobserved factors in the regression function are not related systematically to the observed factors.[23] Equation (1) is estimated using OLS with different linear and nonlinear specifications of the relationships between **Y** and **X**.

The main policy variables of interest are the presence of low-cost carriers on a given route (lcc) and the impact that saturation conditions in the Mexico City airport have on prices (airportsat). The sign and magnitude of these variables can provide evidence on the potential gains that can be expected from implementing sound competition policy in the sector. Policymakers can influence the presence of low-cost carriers on routes, perhaps indirectly, by enforcing competition law and enacting sound competition policies that remove impediments to the entry and expansion of competitive airline suppliers.

[23] Further below this assumption is relaxed and parameters are estimated based upon the instrumental-variables estimator.

With respect to the impact of saturation conditions in the Mexico City airport, Mexico City is different in many ways from other city airports and these factors are controlled for through other independent variables such as average distance per route, income, demand, etc. In addition, the variable (airportcost) is used to control for the maximum price that airports can charge for services such as takeoff/landing fees, platform and security costs, etc. Adding this variable controls for the fact that airline prices are higher when airports charge higher prices, *ceteris paribus* and airport charges should be higher on routes where costs are higher, i.e., in those airports that are congested. Because the variable airportcost is included in the regressions, the Mexico City dummy variable (airportsat) thus picks up: (1) the impact of very high barriers to entry at the Mexico City airport, and (2) the lack of potential competition at the Mexico City airport — two competition policy concerns that can be addressed by policymakers by implementing market-based mechanisms (*e.g.*, auctioning off slots, implementing peak-load slot pricing, etc.) to alleviate slot congestion at the Mexico City airport and ensure that slots are utilized and assigned in the most efficient manner.

There are several additional independent variables measuring competition that are included in estimating equation (1). The total number of competitors on a given route is included. All else equal, as the number of competitors increases so should the intensity of competition and thus result in lower prices.[24] A dummy variable is included whose value is one if the two incumbent operators — Aeromexico and Mexicana — compete and offer service on the route, otherwise the variable is zero. The sign and magnitude of this variable can provide some evidence on the strength of competition between the two major airlines in Mexico. Finally, a dummy variable is

[24] Under the theory of contestability, however, there would not necessarily be a negative relationship between number of competitors on a route and average prices.

included whose value is one if there is codesharing between Mexicana and Aeromar for the flight and route in question, otherwise the value is zero. Upon reviewing the data it was noticed that Mexicana and Aeromar prices were quite high on some routes and further review showed that on these routes, Mexicana and Aeromar codeshared their flights instead of competing.

In addition to these independent variables, equation (1) is estimated using a number of additional independent variables to control for other factors that can influence airline prices. The literature identifies economies of density and economies of distance as being two important determinants of airline costs, Caves, Christensen and Trethway (1984) and Brueckner and Spiller (1994). The inverse of distance in kilometers between the origin and destination city is added as an independent variable (on the assumption that price is not likely linearly related to distance) as well as the total number of passengers that traveled the route in the previous year for the month in which the data were collected. The income of the origin city — 2007 GDP per capita measured in thousands of Mexican pesos — is added controlling for demand differences among different routes.

Price discrimination is a common pricing strategy utilized by airlines. A tool that airlines frequently use is to distinguish between those customers who book their travel weeks in advance and those who book their travel a short period of time before the departure date. The latter are more likely inelastic demand customers while the former tend to be more price elastic. Thus, in theory, a variable measuring time between the reservation and departure date should affect price. The leisure variable controls for this influence on price and has a value of one if the time between the reservation and the departure date is greater than two weeks and the reservation has a Saturday night stayover, otherwise the variable is zero.[25] Another variable that attempts to control for potential price discrimination in our model is whether the destination city is considered a tourist attraction. Leisure customers are more likely to fly to tourist destinations and thus more likely to be price elastic.

Four models were estimated for equation (1). Model (1) and Model (2) include all the independent variables discussed above; the only difference between the two models is that Model (1) estimates equation (1) as a linear relationship between price and the regressors while Model (2) estimates equation (1) as a log-linear (single-log) relationship. Model (3) and Model (4) drop the independent variables that were not significant in Models 1 and 2. Model (3) is a linear model while Model (4) is a log-linear model. In addition, Models 3 and 4 drop those observations (51 in total) where the total number of passengers in the previous year were zero, according to the SCT data.[26] Heteroskedasticity was detected in each of the four models, thus the coefficients' standard errors were estimated using the Huber-White-sandwich estimator of the variance.[27] Table 7 presents the results.

The main policy variables in this study, lcc and airportsat, are highly significant in each model. Similar to the conclusions with the simple statistical analysis, the presence of low-cost carriers on a route is associated with significantly lower prices, *ceteris paribus*. Likewise, flying into or out

[25] Airlines tend to charge business customers a higher price than non-business customers and requiring a Saturday night stay over is a means by which airlines can identify whether the passenger is likely a business customer or not. Business customers are less likely to stay over a Saturday night than are leisure customers.

[26] These routes represent very low demand routes in the year prior to when the data were collected. In some instances the data did not make sense as they indicated that there were flights flown for the routes in question but no passengers traveled on the route. Average prices on these 51 routes were lower than average prices for all the routes. The Model (3) and Model (4) results are fairly robust to these data exclusions as the results do not change in any material way if we include all the observations to estimate Model (3) and Model (4).

[27] The robust option in Stata after the regress command was used.

of the Mexico City airport is associated with significantly higher prices, *ceteris paribus*. The magnitude and percentage impact of the price differences for these two variables is discussed further below.

TABLE 7
MODELS OF AVERAGE AIRLINE PRICES IN MEXICO, OLS ESTIMATES

	Price (Model 1)	**lnPrice (Model 2)**	**Price (Model 3)**	**LnPrice (Model 4)**
1/Distance	573.66***	147.12***	827.86***	212.28***
pass08	-0.029***	-0.005*	-0.029***	-0.005***
gdpcap07	-0.001	-0.00002	-0.001	-0.0001
Leisure	0.033	0.003		
Touristdest	-0.029	0.003		
Airportsat (Mexico City)	1.33***	0.379***	1.04***	0.329***
Airportcost	0.001	.0006**	0.0006	.0005*
Ncomp	1.41*	0.447**	1.25***	0.410***
ncomp^2	-0.198*	-0.064**	-0.185***	-0.061***
Lcc	-0.849*	-0.345***	-0.685***	-0.295***
Incumbentcomp	-0.889*	-0.236***	-0.610**	-0.173**
Cdshmexmar	1.15***	0.277***	1.41***	0.319***
_cons	-1.33	-0.916**	-.660	-0.784
F-stat	13.20	27.09	19.45	43.34
R-sq	0.481	0.506	0.534	0.545
Rmse	1.572	0.406	1.51	0.398
N	429	429	409	409

$^{*}p<.05$, $^{**}p<.01$, $^{***}p<.001$

There are several additional important findings in Table 7. The leisure and touristdest variables did not turn out to be statistically significant at conventional measures of statistical significance.

The variables controlling for economies of density and distance (pass08 and distance) are significant and have the hypothesized signs.[28] Increasing the distance travelled by one standard deviation (611 km) is associated with approximately a 6-13% decrease in price. Increasing monthly passengers by one standard deviation (10,550) is associated with approximately a 5-11% decrease in price.[29] GDP per capita has a small impact on price and is not significant at the 5% level in any the models.

The results for number of competitors, ncomp, require some explanation. In the statistical analysis it was observed that the mean airline price increased with the number of competitors until a threshold number of competitors was reached, at which point mean airline prices started to decrease, indicating that perhaps the relationship between airline prices and number of competitors was nonlinear. After estimating equation (1) with just ncomp included in the equation — which turned out to be positive but not significant — Ramsey's RESET was utilized to test the null hypothesis of no misspecification. The RESET test rejects the null hypothesis, so the square of ncomp was included as an independent variable.[30] These results show that as the number of competitors on a route increases, average price increases but at a decreasing rate. Holding constant the number of low-cost carriers on a route as well as all other variables, prices increase with the number of competitors until the 5th or 6th competitor is added (depending on the model in question) at which point prices decrease. The finding that prices increase with the number of competitors may indicate reverse causality where high prices draw more competitors

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[28] Recall the distance variable is the inverse of kilometers for the route in question, thus making interpretation of the point estimates more complex. As distance increases, the inverse of distance decreases. Alternatively, as the inverse of distance increases, distance decreases, thus explaining the positive coefficient on the distance variable.

[29] Based upon percentage change from the mean value of price, 2.87.

[30] Interaction effects between the number of competitors and the existence of a low-cost carrier were also included in the model but it did not alter the conclusions in Table 7.

into the market. To address this problem, below it is assumed that the number of competitors, as well as lcc and pass08, are endogenous and equation (1) is estimated using two-stage least squares.

Finally, there are three additional independent variables that significantly affect price according to the regression analysis. First, when there is competition between Aeromexico and Mexicana on a given route average prices are lower, holding all other factors constant. The results were significant in each model. Second, when Mexicana and Aeromar codeshare on a given route, average prices are higher, holding all other factors constant, with the results being significant in each model. Finally, in two of the models, airport charges were positively and significantly associated with higher average prices.

Table 8 below converts the point estimates for the variables airportsat (Mexico City dummy), lcc, incumbent comp and cdshmexmar into their percentage impacts on the dependent variable for each of the 4 models that we estimated.[31] According to Table 8, average prices are between 36 and 46 percent higher in Mexico City. All four models control for airport charges and other important determinants, and this result is interpreted as the cost of high entry barriers and lack of potential competition due to saturation conditions in the Mexico City airport.

For those routes that contain at least one low-cost carrier, average prices are between 24 and 30 percent lower. The estimates are fairly close for all four models. Competition between Aeromexico and Mexicana is associated with average prices that are between 16 and 31 percent lower than when competition is not present between these two airlines. Finally, codesharing

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[31] For the linear models—Models (1) and (3)—we divided the point estimates by the mean value of the dependent variable, while for the nonlinear models—Models (2) and (4) the percentage impact was calculated using the formula e^{β}-1.

between Mexicana and Aeromar is associated with average prices that are between 32 and 49 percent higher than when these airlines do not codeshare.

TABLE 8
PERCENT IMPACT ON AVERAGE PRICES

	Model 1	Model 2	Model 3	Model 4
Airportsat (Mexico City)	.463***	.461***	.359***	.390***
Lcc	-.296*	-.291***	-.239***	-.255***
Incumbentcomp	-.310*	-.210***	-.212**	-.159**
Cdshmexmar	.401***	.319***	.491***	.376***

*p<.05, **p<.01, ***p<.001

Using OLS to estimate the parameter values in equation (1) results in unbiased parameter estimates if certain assumptions hold, otherwise the point estimates are biased. An important assumption is that:

$$E[u|x_1, x_2,\ldots,x_k] = 0$$

This is known as the zero-conditional-mean assumption and requires that the regressors be contemporaneously uncorrelated with the error term. Whenever the zero-conditional mean assumption holds, the regressors are said to be exogenous and use of OLS linear regression generally produces unbiased estimates of the parameters. Whenever there is contemporaneous correlation between the error term and the regressor, however, the regressor is said to be endogenous, and the parameter estimates from OLS, β^{OLS}, can no longer be considered to be unbiased or to converge to the true parameters as the sample size increases, a condition known as "consistency". In this case, other estimation procedures can be used to obtain better parameter estimates. Instrumental-variables (IV) estimation is one such estimation procedure that provides consistent parameter estimates.[32]

There are at least three independent variables in equation (1) that may be simultaneously determined with the dependent variable price and thus considered endogenous. They are: existence of low-cost carrier on a route (lcc), the number of competitors on a route (ncomp), and the number of passengers in 2008 on the route.[33] In order to determine the robustness of the conclusions described above, instrumental variables are used to estimate equation (1) and test whether these regressors are actually endogenous.

In theory, it is possible that the decision of carriers to enter a particular route is based, in part, on the average prices that exist for the route. All else equal, profits on a route are positively correlated with higher prices so we would expect to observe a positive relationship between the existence of carriers on a route and prices.[34] If so, the error term in equation (1) would be part of the error term in an equation estimating the existence of carriers, thus biasing the parameter estimates. To see this for lcc, rewrite equation (1) as follows:

(2) $$\mathbf{Y_{price}} = \beta_0 + \beta_1 * LCC + \mathbf{u_{price}}$$

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[32] Consistency means that as N goes to ∞ the estimates will converge to their respective population parameters. The IV estimator is not an unbiased estimator, however. Moreover, use of IV estimators comes at a cost of having a larger variance-covariance matrix. Because the IV estimator also is biased and has a larger variance than OLS, it is possible that the OLS estimator could be preferred based upon the mean square error criterion. See Peter Kennedy, *A Guide to Econometrics*, Third Edition (1992).

[33] Two other variables, incumbentcomp and cdshmexmar, are strategic decisions of the airlines that are likely based in part on unobserved factors that affect profitability of these routes and may also be correlated with the error term. Thus, treating these variables as exogenous might result in biased parameter estimates for these variables.

[34] Interestingly, using logit to regress LCC on the natural log of prices results in a negative and significant relationship, holding constant distance, gdpcap and number of passengers. Regressing ncomp on the natural log of prices, with and without controls, did not result in significant relationship between prices and ncomp. The same conclusion holds for prices and the number of passengers.

And write the equation for low-cost carrier as:

(3) $$\mathbf{Y_{Lcc}} = \alpha_0 + \alpha_1\text{*Price} + \mathbf{u_{Lcc}}$$

Simple algebra shows that the error term $\mathbf{u_{price}}$ is part of equation (3).[35] When the disturbance term $\mathbf{u_{price}}$ is higher — *e.g.*, due to an exogenous shock not captured in any of the other regressors in (2) — not only is the dependent variable $\mathbf{Y_{price}}$ higher but so is the low-cost carrier variable. Thus, too much "credit" is given to the low-cost carrier variable in explaining average price. The OLS procedure assigns, in error, some of the disturbance-generated variation of price to the low-cost carrier regressor with which that disturbance is contemporaneously correlated. If true, then utilizing OLS to estimate β_1 thus results in bias estimates and using IV to estimate equation (1) can minimize the bias.[36]

In economic terms, the issue is whether equation (1) relating average price to various measures of demand, capacity, number of firms, etc., is a demand function, measuring the decisions of customers in response to price, or a supply function, measuring the decisions of firms in response to price. In reality, a market price is determined by the *intersection* of consumers' demand functions and firms' supply functions. Instrumental variable procedures are factors that cause the

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[35] Substitute $\mathbf{Y_{price}}$ in equation (2) into equation (3) and solve for LCC.

[36] It is possible, however, that lcc and ncomp in equation (2) are only weakly endogenous and use of IV may not result in better estimates. The decision by carriers to enter a particular route will likely be influenced, in part, by average prices for that route. And, all else equal, higher average prices should lead to greater profits and provide a greater incentive to enter the route. Over time, however, we would expect rents to be competed away and in equilibrium the relationship between prices and low-cost carriers may be weak. Unfortunately, we do not have data on how long a low-cost carrier has been providing service on the route in question. In addition, as discussed in footnote 34, the relationship between price and lcc was negative in our data set and nonexistent for price and ncomp. Moreover, the decision of a carrier to enter a particular route will more likely be influenced by the previous period prices than by current prices. With respect to number of passengers, recall that our variable pass08 measures number of passengers in 2008 not in 2009 when price data were obtained, thus lessening the likelihood that the variables are simultaneously determined.

supply curve to shift against a fixed demand curve and vice-versa, which enables the data to trace out separate supply and demand curves.

The IV procedure produces a consistent estimator in a situation in which a regressor is contemporaneously correlated with the error. In order to use IV to estimate equation (1), we need instruments for the endogenous explanatory variables. To derive consistent estimates of (1) we must find an IV that satisfies two properties: the instruments must be highly correlated with the endogenous variable and yet be uncorrelated with **u**. For lcc the share of routes at the two endpoint airports that are served by low-cost carriers is used as the instrument. That is, all the routes that are part of the two endpoint airports are summed and the percent of those routes that have at least one low-cost carrier is used as the instrument. A regression of lcc on this variable was positive and highly significant. For ncomp the number of carriers serving the endpoints is used as the instrument. That is, for each endpoint of a route the number of carriers serving that airport is determined and the two numbers are added. A regression of ncomp on this variable was positive and highly significant. Finally for pass08 the geometric mean of the populations at the endpoints of the routes is used as the instrument. A regression of pass08 on this variable was also positive and highly significant.

Table 9 below presents the IV regression results. There are two models, Model (5) and Model (6). In Model (5) lcc, ncomp and pass08 are treated as endogenous while in Model (6) only lcc and pass08 are treated as endogenous and ncomp is treated as exogenous.[37] As in the case with the

[37] After estimating Model (5) a Hausman test failed to reject the null hypothesis that differences in coefficients were not systematic. A difference in Sargan C test, however, did find support for the existence of endogenous variables. Additional Hausman and difference in Sargan C tests agreed that ncomp was likely exogenous.

OLS estimates, the estimates from the model in Table 9 are efficient for arbitrary heteroskedasticity and are robust standard errors.[38]

The results contained in Table 9 generally confirm the OLS estimates found in Table 7.

TABLE 9
MODEL OF AVERAGE AIRLINE PRICES IN MEXICO, IV ESTIMATES

	Lnprice (Model 5)	**lnprice (Model 6)**
Distance	134.60***	136.23***
pass08	-0.017*	-0.01*
gdpcap07	-0.0002	-0.0001
Airportsat (Mexico City)	0.585***	0.534***
Airportcost	0.0009**	0.0009***
Ncomp	0.107	0.470**
Ncomp^2		-0.055**
Lcc	-0.369*	-0.429**
Incumbentcomp	-0.118	-0.260*
Cdshmexmar	0.311**	0.267**
_cons	-0.975*	-1.254**
F-stat	32.86	33.67
R-sq (centered)	0.4407	0.4479
Rmse	0.4258	0.4231
N	459	459

*p<.05, **p<.01, ***p<.001

With respect to the two main policy variables in this study, lcc and airportsat (Mexico City), the IV regressions also find these two variables to be significant. Codesharing between Mexicana and

[38] We use the ivreg2 command in Stata and the generalized method of moments estimator. Our results do not change in any material way if we assume the presence of *i.i.d.* errors.

Aeromar is found to be significant consistent with the OLS estimates. The only discrepancy between the OLS and IV estimates involves the variable incumbentcomp, whether the two incumbents compete on the same route. The four OLS models found this variable to be negative and significant. The IV estimate in Model (5) finds the variable to be negative but not significant, and this occurs when ncomp is treated as endogenous. As described in footnote 37, however, statistical tests suggested that ncomp may be treated as exogenous which is done in Model (6). In that model, competition between Aeromexico and Mexicana is negative and significant.

Table 10 below compares the percentage impacts from models 2 and 4 of the OLS estimation and models 5 and 6 from the IV estimation, all four models have as the dependent variable natural log of prices. With respect to the airportsat (Mexico City) variable, using IV significantly increases the magnitude of the impact. The OLS estimates result in 39-46 percent higher prices while the IV estimates result in 70-80 percent higher prices. With respect to lcc, the OLS and IV estimates are similar, suggesting an average 30 percent impact on prices. The impact of incumbent competition under the IV estimate — Model (6) — and the OLS estimates is similar, suggesting a 20 percent impact. Finally, the OLS and IV estimates for codesharing between Mexicana and Aeromar are similar as well, suggesting a 33 percent impact on average prices.

TABLE 10
COMPARISON OF PERCENTAGE IMPACT ON AVERAGE PRICES
OLS vs. IV ESTIMATES

	Model 2 OLS	**Model 4 OLS**	**Model 5 IV**	**Model 6 IV**
Airportsat (Mexico City)	.461***	.390***	.795***	.706***
Lcc	-.291***	-.255***	-.309*	-.349**
Incumbentcomp	-.210***	-.159**	-.113	-.229*

Cdshmexmar	.319***	.376***	.365**	.306**

*p<.05, **p<.01, ***p<.001

V. Policy Implications and Conclusions

The point estimates from the OLS and IV regressions can be used to estimate the impact that policy reforms can have on consumer welfare. With respect to the airportsat variable, since airport prices and other factors are controlled in the models, the airportsat variable is measuring the impact that high entry barriers and lack of potential competition is having on airline prices flying into or out of Mexico City. Market-based policy reforms can lower these barriers and increase potential competition, thus affecting average prices. The average price impact of the models listed in Table 10 is approximately 60 percent. Thus, to the extent that sound, market-based policy reforms eliminate saturation conditions in the Mexico City airport, the model predicts airline prices to or from Mexico City would decrease by approximately 60 percent. The average price for routes to or from Mexico City was 3,034 pesos and there were approximately 15.7 million domestic passengers in 2008 that flew on such routes. Using a price elasticity of -1.2 and a linear demand curve (*i.e.*, Q(p) = a – bP), a 60 percent price reduction would result in a total of approximately 25 million passengers flying on such routes.[39] And, the change in consumer surplus would be approximately 38.9 billion pesos per year (approximately 3 billion US$).[40]

Similar calculations are performed, using the same assumptions, to estimate the impact on airline prices from policy reforms that eliminate and reduce unnecessary restrictions on the entry and expansion of low-cost carriers. According to the OLS and IV estimates, the existence of at least

[39] Using the formula $q_2 = q_1[1-\varepsilon((p_1-p_2)/p_1)]$.

[40] Using the formula change in consumer surplus = $-(p_2-p_1)*(q_1+q_2)/2$.

one low-cost carrier on a route is associated with prices that are approximately 30 percent lower. The data show that in 2008 there were approximately 7 million domestic passengers in Mexico that flew on routes where there were no low-cost carriers and the average price on these routes was 3,151 pesos. Under the assumption that policy reforms can increase incentives for low-cost carriers to enter to serve one half of these passengers (3.5 million), then a 30 percent price reduction would result in a total of approximately 4.7 million passengers flying on such routes.[41] And the change in consumer surplus would be approximately 3.87 billion pesos per year (approximately 300 million US$).

[41] Admittedly, policy reforms are not likely to incentivize low-cost carriers to enter each and every route in Mexico as there were likely be routes where demand is so sparse it could only support a single carrier.

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