Multimarket Contact and Tacit Market Sharing Agreements:

Empirical Evidence from the US Airline Industry

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Abstract

This paper offers an empirical analysis of the relationship between multimarket contact and both price and market concentration, using data from the US airline industry. We exploit substantial across-market heterogeneity in both market size and market concentration, present in this industry. By means of investigating the MMC-concentration relationship, we are able to test for existence of tacit market-sharing agreements. Given the structure of the US airline industry, where the major carriers operate hub-and-spoke networks that make it relatively easy for them to enter and exit markets by varying the way passenger traffic is distributed within their networks, we argue that the evidence consistent with existence of such arrangements is a positive relationship between the level of multimarket contact and market concentration. Results of our data analysis show positive MMC-concentration relationship on the less concentrated routes only. The relationship is negative on markets that are more concentrated. This suggests that airlines appear to use more concentrated routes to increase the extent of MMC, and then use the increased level of multimarket contact to soften competition on the less concentrated markets.

Keywords: multimarket contact, market sharing agreements, collusion

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I. Introduction

Belleflamme and Bloch (2004) presented theoretical underpinnings for existence of market sharing agreements in the imperfectly competitive markets. This paper is among the first contributions to empirically evaluate this theoretical proposition, using data from the US airline industry. We use the DB1B data for 2003-2008, aggregated at the market level. These data allow us to evaluate the degree of concentration on over 8,000 airport-pair markets, including both concentrated markets with non-stop services and more competitive markets, where only one-stop services are available. Our dataset indeed boasts substantial variability in the levels of market concentration. From this dataset, we are also able to evaluate the extent of multimarket contact (MMC) between the US carriers. It has been argued both theoretically (Bernheim and Whinston, 1990) and empirically (Evans and Kessides, 1994) that higher level of MMC facilitates tacit collusion, leading to higher prices. Further, one of the results of Belleflamme and Bloch's paper is fiercer competition on more concentrated routes, implying stronger MMC-price relationship on routes that are less concentrated.

The US airline industry is ideally posed for investigation of market sharing arrangements. In addition to the sheer number of diverse markets the players operate on, the hub-and-spoke networks established by the major US carriers make it relatively easy for the airlines to vary their presence on individual routes by changing how the passenger traffic is channeled within those networks. Two airlines may therefore be present at each spoke airport in the country, but effectively compete only on handful of routes. Even if the carriers compete on every individual market, market sharing agreements would imply that different routes will be dominated by different airlines. The extent of multimarket contact can then serve to reinforce such division. In presence of tacit market sharing agreements of this kind, an airline will enter a market already inhabited by its rival on a smaller scale, the larger the level of MMC is. Then, presence of market sharing agreements implies a positive relationship between the extent of multimarket contact between the players and the level of market concentration (as measured by the Herfindahl-Hirschman Index). Note that the basic theory behind MMC as a factor facilitating collusive behavior does not predict any clear relationship between multimarket contact and market concentration – the idea there is maintaining collusive price, without regard to the firms' market shares on individual routes.

Our view of market sharing agreements is different from how this phenomenon is commonly thought of: we do not visualize firms literally staying away from the rivals' markets, but merely limiting their presence on them. This view is however quite justified by both the structure of the industry being studied and the role that multimarket contact allegedly plays in the airline industry as a factor facilitating collusive behavior. For this reason, for instance, it is not quite correct to view MMC itself as a measure of market sharing agreements. While one can build an argument that in presence of such agreements the extent of multimarket contact should be lower than in their absence: it is also true that MMC can change for reasons completely unrelated to any market sharing arrangements that might be taking place (for instance, via airline bankruptcies or mergers).

We take advantage of the panel nature of our dataset, and employ market fixed effects estimation technique to investigate the impact of multimarket contact on both price and market concentration.

Instrumental variable approach is used to account for potential endogeneity of MMC in the MMC-concentration regressions – we devise an instrument based on the high correlation between carrier's network size and the level of multimarket contact. Results of our data analysis show a negative MMC-concentration relationship on markets that have high or intermediate concentration levels. In contrast, we find evidence of a positive MMC-concentration relationship on the less concentrated routes. Estimation results of the MMC-price relationship both confirm Evans and Kessides' findings, and demonstrate stronger relationship on less concentrated routes. This suggests that the effect of MMC as factor facilitating tacit price collusion is stronger in more fragmented markets.

The overall picture of the competition and market sharing that emerges from our data analysis is the following. The airlines reinforce their tacit collusion by building small-scale presence on the concentrated markets, where their key rivals (as measured by the extent of MMC) are present. The multimarket contact thus built-up is then used to limit the intensity of competition on less concentrated routes, as evidenced by both stronger MMC-price relationship on those markets and the quasi-market sharing arrangements we detect there. A somewhat encouraging conclusion of our study is that the extent of any tacit market sharing arrangements on the US airline markets is limited to routes which are already competitive.

The rest of the paper is organized as follows. Section II reviews relevant literature. Section III discusses the data. This is followed by presentation of estimation methodology and results in Section IV. Section V concludes.

II. Related Literature

This paper is related to two strands of the literature. As we attempt to analyze the relationship between multimarket contact and prices at different levels of market concentration, our work extends literature on the empirical measurement of the impact of MMC on prices. As we study the role of multimarket contact as a potential entry barrier through empirically measuring the relationship between MMC and market concentration; our paper relates to the literature on market sharing agreements between firms competing on a multitude of markets, whose theoretical rationale is laid out by Belleflamme and Bloch (2004).

The first formal theory linking MMC to competition is developed by Bernheim and Whinston (1990). The theory predicts that MMC is irrelevant to collusive pricing when products are homogeneous, firms and markets are identical, and firms have constant returns to scale. Whereas, when markets differ in terms of firm numbers and discount factor, an increase in MMC can facilitate collusion. Collusion can be also facilitated via MMC when firms are heterogeneous in terms of costs. However, Bernheim and Whinston also show that sometimes MMC makes collusion harder; for example i) with identical firms and heterogeneous markets prices can fall in some markets because of MMC, while raising in other markets; and ii) when markets are identical and firms have different costs, MMC can cause either higher or lower prices depending upon the discount factor.

Based on this theoretical framework, an empirical literature has flourished testing the main prediction which states a positive link between multimarket contact and prices. We can mention Piloff (1999) finding a positive relationship between MMC and profitability in the banking industry; Jans and Rosenbaum (1997) provides empirical evidence in support of a positive relation between MMC and collusion for the cement industry. Busse (2000), examining the cellular telephone industry, finds not only that MMC allows harsher punishment, but also finds evidence that it helps coordination through price signaling; Fernandez and Marin (1998) find empirical evidence of a positive relation between MMC and price competition for the Spanish Hotel industry. Feinberg (1985) analyses the impact on price-cost margins in place of price for several industries, finding more support for the mutual forbearance hypothesis in the firm than in the industry-level data. Parker and Roller (1997) study multimarket contact and collusion in the mobile telephone industry. This theme has been explored also in the airline industry (e.g. Ciliberto and Williams 2012; Evans and Kessides 1994; Singal 1996) confirming the prediction that contacts can cause higher prices. Neither of these studies, however, has explicitly addressed the question of the differences in the estimated MMC-price relationship among the markets with different levels of concentration. Further, most studies in the literature treat MMC as exogenous – an exception here is Ciliberto and Williams (2012).

A smaller empirical literature has looked at the effects of MMC on non-price product competition in the airline industry: Prince and Simon (2008) look at service quality in terms of flight-delays, and Bilotkach (2011) studies the impact on frequency. Both these papers provide evidence of higher delays and lower frequency, respectively, as MMC is enhanced.

The literature on market sharing agreements, outside of the well-studied issue of collusion in procurement auctions[1] (e.g., Porter and Zona, 1993; Pesendorfer, 2000; Porter, 2005), is rather scant. Indeed, we have only two theoretical papers (Belleflamme and Bloch 2004; Roldan 2012) dealing with market sharing agreements in more general context. The study by Belleflamme and Bloch demonstrates that (i) bilateral collusive agreements may be easier to sustain than multilateral ones; (ii) a stable network exists where firms on smaller markets forms links to firms on larger markets, while firms on larger markets are more likely to compete head-to-head; and (iii) competition may tend to be tougher on more profitable markets. Roldan shows that market sharing agreements are harder to sustain in presence of antitrust authority than in its absence. Results of our data analysis are consistent with the hypotheses proposed by Belleflamme and Bloch's theoretical investigation. Mariuzzo, Morales and Tabacco (2013) develop a model of networks and explicitly test empirically whether firms compete head-to-head or carve out geographic markets in an endogenous multimarket contact setting; that is, the authors deals with the economic endogeneity of MMC. Whereas our study is concerned with tacitly price collusive behavior, facilitated by multimarket contact between the firms, and how multimarket contact may serve as factor limiting market competition.

[1] Collusion in auctions mostly deals with the outright criminal practice of bid rigging.

III. Data

The data for our analysis comes mostly from the US Department of Transportation (US DOT). This government agency collects quarterly Origin and Destination Survey – the dataset known in the industry as DB1B. The DB1B is a 10 percent sample of actual itineraries, compiled quarterly by the US DOT. Each entry in the dataset includes fare paid (net of taxes and fees), class of service; and detailed information on routing, including identity of airlines selling the ticket and operating each flight, distance traveled, all intermediate airports visited. The destination of the trip is coded through the directional break in an itinerary. The US DOT also provides aggregated data, based on the raw DB1B information – this is the data we will use in our analysis.

The data is aggregated by the agency annually for 2003-2008 at the origin-destination-airline-airport-market level, for all markets involving medium and large hub airports[2], provided the total passenger volume on a market is at least ten passengers per day. The data is aggregated non-directionally, meaning that passengers traveling from Los Angeles to New York JFK airport are lumped together with the passengers traveling in the opposite direction. Regional carriers providing services as agents of the corresponding major airlines (e.g., American Eagle flying for American Airlines) are lumped together with the majors during the aggregation. Eventually, for each airline carrying at least 10 percent of the passengers between the two airports, the aggregated data gives the information about the carrier's market share, total number of passengers in DB1B dataset, number of zero-fare passengers (representing award tickets purchased by frequent fliers), and total revenue. A number of time-invariant market characteristics are also presented (such as distance), which are essentially of little interest to us, as they will be absorbed by the market-level fixed effects when our methodology of choice is applied. The aggregated data allows us to obtain a clear picture of the actual extent of competition on the US domestic market. Most importantly, we are able to observe airlines' market shares on those markets, where non-stop service is not feasible, and passengers end up making a stop at one of the major carrier's hub airports on the way. At the same time, the aggregated data does not allow us to observe the passengers' routing. For instance, we will only observe total number of passengers carried by American Airlines between Los Angeles and New York JFK airport, but we will not know how many of those passengers used the carrier's non-stop services between the two gateways, and how many might have traveled on one-stop itineraries, connecting at either Chicago O'Hare or Dallas – Ft. Worth airports.

Overall, our dataset includes about 100,000 airline-market-year level observations, which cover over 8,300 airport-pair markets. Each of the markets involves at least a large or a medium hub airport: however, the other endpoint may be a small hub or a non-hub airport. Essentially, the only markets we do not have in our dataset are routes between small hub and/or non-hub airports – these are typically thin markets. We thus have a six-year panel, showing market shares of the airlines on most important markets in the United States. The key variables we will use in our analysis, which we can compute from

[2] According to the Federal Aviation Administration (FAA) classification, a large hub airport is defined as the airport handling at least 1 percent of all passengers on the US domestic scheduled commercial passenger market. An airport handling fewer than 1 percent but more than 0.25 of a percent of all US domestic passengers is classified as a medium hub airport. In 2008, 31 airports have been classified as large hubs, and further 44 as medium hubs.

this raw data, are average airfare; a measure of market concentration; and measures of multimarket contact, at both airline-market and market levels.

The average airfare (net of taxes and other fees, as reported in DB1B) charged by an airline on a given market in a given year is computed from this data straightforwardly as:

$$Price = \frac{Revenue}{Total\ Passengers - Zero\ Fare\ Passengers}$$

We can also easily compute, for each airport-pair-market and each year, the standard measure of concentration – Herfindahl-Hirschman Index (HHI). HHI is defined as the sum of squared of competitors' market shares. We should note three caveats here. First, since market shares in our dataset are estimated based on the ten percent sample of tickets rather than directly measured, we need to be aware that HHI will be measured imprecisely. Second, since carriers with less than 10 percent market share are excluded from calculations, the HHI we will compute underestimates the actual concentration on the market. This issue could be more important, the more fragmented the markets are[3]. Third, multi-airline itineraries are sometimes responsible for more than 10 percent of all passengers carried on the market[4]. Such options (coded as "99" in the dataset) are treated as a separate "competitor" for purposes of computing HHI.

The other key variable for our analysis is the extent of multimarket contact (MMC). Here we follow Bilotkach (2011) and use one of the measures he proposed in that study. Bilotkach denoted this measure the 'absolute' extent of multimarket contact (AMMC). Computing AMMC involves counting the number of markets in which the airline competes with the other carrier(s) that it encounters on a given route. Specifically, for each pair of airlines (*k* and *j*), we count the number of airport-pair markets in which the two carriers both provide service (denote this number as n_{kj}). Rather, we compute the number of markets, on which both airlines' market share exceeds 10 percent. Then, the extent of MMC for the airline *k* in market *i* will be calculated as:

$$AMMC_k^i = \sum_{j \neq k} I_{kj}^i n_{kj}$$

[3] The mean sum of the market shares at the year-market level is 0.884, ranging from 0.784 for markets with HHI<0.2 to 0.956 for those markets with HHI>0.8.

[4] These represent about 2.3 percent of all observations. About three quarters of cases where multi-airline options are responsible for more than 10 percent market share occur on longer-haul markets, with one-way direct distance between endpoints exceeding 2000 miles (mostly representing coast-to-coast routes and/or markets between mainland and Alaska/Hawaii).

where I_{kj}^i is simply the indicator of whether the two airlines both offer service in the given airport-pair market; the summation is done over the population of the airlines[5]. Multi-airline options will be disregarded when performing this calculation.

When we aggregate the data to the market level to explore the HHI-MMC relationship, we will use the market-level measure of multimarket conduct, which is the average of the above-described measures of "absolute" multimarket contact for a given market, or:

$$AvgMMC^i = \left(N^i\right)^{-1} * \sum_k I_k^i * AMMC_k^i$$

where N^i is the number of unique carriers operating on the market *i*, and I_k^i is the indicator of the airline *k*'s presence on the market *i*. The summation is again performed over all the airlines in the dataset.

The following tables present the rather detailed descriptive statistics for our key variables. Table 1 essentially gives average and standard deviations (based on six annual observations in each case) for the number of markets on which various pairs of US airlines meet. That is, Table 1 effectively presents the values for n_{kj}, which enter into calculations of AMMC and AvgMMC. The main observation that comes from these numbers is that there appears to be much greater variability in the extent of MMC across different pairs of carriers than within individual pairs of airlines. The range of multimarket contact across pairs spans from zero (for instance, Hawaiian does not compete on a single route with five of fifteen airlines includes into Table 1) to 1182 (the average number of airport-pair markets on which both American and Delta operate with market share of at least 10 percent). While the extent of variability in the level of multimarket contact within pairs is considerable (the mean coefficient of variation across all the pairs is about 0.66); this figure becomes less impressive if we restrict our attention to the large airlines with established networks. For instance, average coefficient of variation for the level of multimarket contact, taken across the pairs comprised of the seven largest airlines in our dataset[6] is only about 0.16.

Table 2 reports averages and standard deviations for the mean airfare, both for the whole sample, and also by airlines and years. The missing value for America West in 2008 is explained by the simple fact that this carrier ceased to exist in the database by that time. America West merged with US Airways in late 2005 – it took another two years for all the itineraries ticketed by this carrier to disappear from DB1B[7]. The numbers in Table 2 are not adjusted for inflation – in fact, the average price increase over time is quite consistent with the cumulative change in the US CPI over the same time period.

[5] Bilotkach (2011) also proposed a measure of MMC relative to the size of the airline's network (that study focused on markets with available non-stop services). We are not using this measure here, since measuring the flight frequency for one-stop operations is a task that is both ambiguous and not obvious.

[6] American, Continental, Delta, Northwest, United, US Airways, and Southwest.

[7] America West officially ceased to exist in 2007, about two years after the merger was closed, when its operating certificate was merged with that of US Airways.

Descriptive statistics for AMMC (airline-market measure of multimarket contact) reported in Table 3 show rather stable values for individual airlines over time, with substantial within-carrier variation for every given year. Exceptions from this pattern are America West, ATA, JetBlue and Frontier. We noted the 2005 US Airways – America West merger above. ATA went out of business in 2008, after years of financial difficulties and downsizing. JetBlue, launched in 2001, was growing rapidly during the time period covered by our study (see Bilotkach, Hueschelrath, and Mueller, 2012 for a study documenting this process). Frontier was undergoing reorganization over the time period covered by the data.

Tables 4 and 5 present descriptive statistics for the market-level measures of MMC and concentration (HHI). These tables are set up in a way to inform the reader about the correlation between the two variables. Generally speaking, and not surprisingly, the more competitive markets are characterized by higher levels of multimarket contact, simply because there are more carriers present on them. Interestingly, our data show that the level of market-level multimarket contact has decreased somewhat over time across all the concentration groups. At the same time, concentration also went down a little across all the MMC groups defined in Table 5. Finally, we note that an average US airline market has HHI similar to what one would expect for a symmetric duopoly. This is in contrast to the fact that most of the markets where non-stop services are offered tend to be monopolies (Perteraf and Reed, 1994; Bilotkach and Lakew, 2013). Evidently, markets where non-stop services are not available (which comprise the majority of routes, although not passengers – see Berry and Jia, 2010) tend to be quite competitive.

Finally, Figures 1 and 2 present the histograms for HHI and AvgMMC. The main purpose of these figures is to inform the reader about the extent of variation in key variables in the data. We can see that our dataset includes markets with very diverse concentration and multimarket contact levels. About a quarter of the year-market observations with MMC=0 represent effective monopolies. The lack of an equivalent mass around HHI=1 is explained by the peculiarities of our dataset. Since competitors with less than 10 percent market share are not included into the dataset; a market with the dominant carrier carrying 95 percent of all passengers would have HHI=0.9025, but AvgMMC for this market would be equal to zero.

IV. Methodology and Results

IV.1 Hypotheses

Before we begin the discussion of the data analysis methodology, we should note that the phenomena we are set to examine are rather complex. While we will use the relationship between the degree of multimarket contact and market concentration to evaluate whether a tacit market sharing arrangement is in place; we must also understand that MMC is well established in the literature as a factor that facilitates tacit collusion. Therefore, the market players face the following trade-off. On one hand, successful tacit collusion requires extensive multimarket contact. On the other hand, market-sharing arrangement in its pure form, while creating market power, should lead to lower extent of MMC. Additionally, while the extent of non-stop competition in the US airline industry appears limited (Peteraf and Reed, 1994; Bilotkach and Lakew, 2013), major network carriers on the US airline market tend to be present in most important airports and operate networks allowing them to compete on a vast number of one-stop markets. Also, lack of non-stop competition should not by itself be construed to imply the presence of a market-sharing arrangement: major carriers operate hub-and-spoke networks, which mostly define their presence on non-stop routes. In most cases, it makes little sense for two airlines to set up their hub at the same airport[8], as economies of hub operations tend to provide an effective entry barrier (Aguirregabiria and Ho, 2010). Further, non-stop entry outside of the airlines' hub-and-spoke networks is often restricted by both the market size and the fact that the carrier is already offering one-stop service on the same markets (Dunn, 2007).

As we noted above, the sort of market-sharing agreement which is consistent with both the structure of the airlines' networks and the role of multimarket contact in facilitating tacit collusion appears to be the one where major network carriers channel traffic within their networks in such a way that some airlines end up being dominant on one set of routes, whereas other airlines dominate a different set of markets. Take as an example a set of markets served out of a decent-sized airport, which is not a hub for any airline (e.g., Tucson, AZ). The tacit market-sharing arrangement of the kind we have just described will involve American Airlines obtaining a dominant position on flights to, say, Boston, while Delta may dominate on the Tucson-Washington route.

We further argue that the extent of multimarket contact should reinforce such tacit market-sharing arrangements for the same reason why it reinforces tacit collusion in general. The more markets are covered by the market sharing arrangements, the harsher the potential punishment for violating this tacit agreement. Further, as we noted above, the structure of the airlines' networks can make such a punishment easier to implement – all that is needed is a redirection of the traffic flow within the network towards the routes dominated by the competitor.

Our logic thus far suggests a fairly simple test for the presence of tacit market sharing agreements. More extensive multimarket contact should lead – other things equal – to more concentrated markets, where such arrangements are present. We further expect that this relationship is more likely to hold on the routes where airlines compete with one-stop rather than non-stop services (i.e., the markets that are otherwise potentially more competitive). We should also note that the 'classical' role of MMC as a factor facilitating collusion does not a priori imply a clear direction of relationship between MMC and market concentration.

To sum it all up, our data analysis will focus on evaluating two simple hypotheses. First, the role of multimarket contact as a factor facilitating tacit collusion will imply the positive MMC-price relationship, as in other studies of this issue. Second, a hypothesis consistent with presence of the tacit market-sharing arrangements in the industry will be positive relationship between the extent of multimarket contact and market concentration.

[8] Yet, Bilotkach and Pai (2013) identify five US airports which serve as hubs for two carriers.

IV.2 Estimation Methodology

In light of the discussion presented in the previous sub-section, our empirical analysis has two objectives. First, we evaluate the role of multimarket contact in sustaining tacit collusion by estimating the price-MMC relationship. Our innovation in this regard, as compared to other studies, is evaluating the intensity of competition on markets with different concentration levels to assess whether the magnitude of the effect of multimarket contact on price will be different at different market concentration levels. Second, we assess whether the observed market structure appears consistent with the presence of tacit market-sharing agreements between the key players. We will also perform a more direct assessment of the role of multimarket contact as an entry barrier, by estimating the MMC-number-of-competitors relationship.

Specifically, the price regression we will estimate will be of the form:

$$\log(P_{ikt}) = \alpha_i + \beta X_k + \phi \log(AMMC_{ikt}) + \gamma Z_{ikt} + \varepsilon_{ikt}$$

Where the dependent variable P_{ikt} is the natural logarithm of passenger weighted airfare charged by airline *k* on market *i* at time *t;* α_i represent market fixed effects; X_k is the vector of airline-specific effects; Z_{ikt} is the vector of control variables; and ε_{ikt} is the error term. The vector of control variables will include the natural logarithm of airline's market share; geometric averages of endpoints' population and average wage rates, at the corresponding Metropolitan Statistical Area (MSA) levels; and year dummies. To handle the well-recognized problem of endogeneity of market share variable, we use the instrument proposed by Borenstein and Rose (1994), which basically is the airline's share of geometric average enplanements at the origin and destination airports. The calculation is as follows:

$$S_{ij}^{IV} = \frac{\sqrt{Pax_{i,j1} Pax_{i,j2}}}{\sum_k \sqrt{Pax_{k,j1} Pax_{k,j2}}}$$

Where $Pax_{i,j1}$ and $Pax_{i,j1}$ represent airline *i*'s total passenger traffic at the origin (*j*1) and destination (*j2*) airports of market *j*. The numerator in the above expression is then the geometric average for airline *i*'s total passenger enplanements at the two endpoints. The denominator is the sum of these geometric averages across all the airlines present at both airports. The correlation between the market share and the instrument in our sample is 0.81, which means that the instrument is clearly not weak.

We infer the possibility of market-sharing agreements in the industry from an analysis of MMC-HHI relationship. Specifically, evidence consistent with existence of market-sharing arrangements would be the positive relationship between the two variables. We will investigate this relationship by estimating the following market-level specification:

$$\log(HHI_{it}) = \alpha_i + \beta X_{it} + \phi \log(AvgMMC_{it}) + \gamma W_{it} + \varepsilon_{it}$$

As before, the specification will employ market fixed effects α_i; airline indicator variables X_{it}; and control variables W_{it}. We will employ the same control variables here as in the price regression, with the exception of the airlines' market shares. As with the price regressions, we will repeat our analysis for various levels of market concentration to investigate whether evidence consistent with market-sharing arrangements are present in both concentrated and more fragmented markets.

An econometric challenge we need to deal with when estimating the market concentration equation is the likely endogeneity of our measure of multimarket contact. Specifically, an unobserved shock that changes the market concentration, such as an airline adding a flight to its hub from a smaller airport, could also lead to changes in multimarket contact (if this additional flight allows the passengers to connect at that hub to the airline's destinations, which were previously not accessible). That is, there is a high possibility that our measure of MMC could be correlated with the error term. To address this problem, we will employ the conventional instrumental variable approach. Specifically, a variable we posit to be correlated with the level of MMC, but not with the error term is the total network size of all airlines operating on the market. Mathematically, the instrument for MMC can be written as:

$$AvgMMC_{it}^{IV} = I_{it}^{MMC>0} \sum_{k} I_{it}^{k} M_{kt}$$

Where $I_{it}^{MMC>0}$ is the indicator for the market-level MMC being positive (so that $AvgMMC_{it}^{IV} = 0$ for markets where $AvgMMC_{it} = 0$); I_{it}^{k} is the indicator for airline k being present on market i in the year t; and M_{kt} is the total number of airports served by airline k in the year t. The summation is performed over all the airlines in the dataset. Then, any change in HHI that does not involve a new airport entry, and may change the measure of MMC, will not change the instrument we employ. We understand that our instrument could still be correlated with the error term, should unobserved HHI shocks be caused predominantly by entry into new airports. However, airport entry/exit events are rarer occurrences than changes in the market-level concentration by the airline changing the extent of its presence at the airports already in its network. The correlation between our instrument and the endogenous variable is quite strong – around 0.85 in our sample.

We will also use this instrument for the degree of multimarket contact in price regressions. While most of the studies of MMC have treated this variable as exogenous, more recent investigations have built an argument for the extent of multimarket contact being potentially endogenous (see Ciliberto and Williams, 2012).

The MMC-HHI relationship can also be affected by the airlines entering and exiting the markets. A market exit, other things equal both increases concentration and reduces the extent of MMC. If MMC serves as an entry barrier, a higher extent of multimarket contact will reduce the number of competitors and increase market concentration, other things equal. This can produce the positive MMC-HHI relationship, but will not necessarily be the evidence of a tacit market-sharing arrangement. To evaluate whether extent of MMC affects entry and exit, we have regressed number of competitors present on the market on the natural logarithm of our measure of multimarket contact. We have however lagged our measure of MMC one year. The primary reasons for using lagged MMC are mitigating endogeneity and avoiding potential reverse causality. The latter problem arises because changing the number of competitors on the route naturally changes the degree of current multimarket contact. That is, we are estimating the specifications of the form:

$$\log(Competitors_{it}) = \alpha_i + \beta X_{it} + \phi \log(AvgMMC_{it-1}) + \gamma W_{it} + \varepsilon_{it}$$

The set of control variables W here is the same we used in evaluating the HHI-MMC relationship. Methodologically, we have estimated the market fixed effects specification treating MMC as endogenous and as exogenous. Additionally, we have also run Poisson regressions (obviously, dependent variable in those specifications is the number of competitors rather than its logarithm). Lack of the impact of multimarket contact on the number of competitors will allow us to rule out the 'MMC as the entry barrier' explanation behind any relationship between MMC and HHI we might uncover.

The last series of regressions we ran for MMC-number of firms actually also rule out some powerful potential alternative explanations to our interpretation of results. Increased concentration may be due not to market sharing agreements, but because of traditional industrial organization theories of entry, mostly encompassed in Shaked and Sutton (1990). These theories predict that if a firm has to choose between entering a market in which it faces competition and one monopoly market, the firm will, other things equal, choose to enter the monopoly market. Whenever entry deterrence occurs, it will make such prediction even more likely. In particular, with sequential entry in the context of multiproduct firms the first mover can prevent entry by product proliferation (e.g. Schmalensee, 1978; Bonanno, 1987; Hay, 1976). Having found that MMC is not responsible for entry/exit, then, we will rule out all those theories of entry and entry deterrence.

IV.3 Results

The reader could have figured from our description of the estimation methodology that our technique of choice is two-stage least squares with market-level fixed effects. The corresponding indicator variables will be used to address airline-specific and year-specific heterogeneity. Finally, we will report standard errors that are robust to both heteroscedasticity across and autocorrelation within markets. In interpreting the estimation results that follow, one should keep in mind that our coefficients are identified by the within-market variation in the corresponding variables.

Our main estimation results are presented in Tables 6 and 7. Table 6 reports results for price specifications, while Table 7 presents output for concentration regressions. We begin by reporting the results for the entire sample, and then proceed to focusing on sub-samples of increasingly more competitive markets. Results in Table 6 are reported for specifications treating MMC as endogenous. Table 7 goes a bit further in this respect and presents results for specifications treating multimarket contact as both exogenous and endogenous variable. Results in these two tables are complemented by Figures 3 and 4, which present a more comprehensive picture behind the MMC-Price and MMC-HHI relationships, respectively, as we gradually decrease the sample size to include more fragmented markets. Figure 5 presents the same evidence for the MMC-number-of-competitors relationship, evaluated at sub-samples of markets with different concentration levels.

Price regressions reported in Table 6 confirm what we know about the MMC-price relationship. Namely, an increase in MMC increases the price airline charges. However, we present this evidence treating the level of multimarket contact as endogenous. Further, as we change the sample to exclude less concentrated routes; we observe that the magnitude of the price effect of multimarket contact increases. As a consequence, fragmented markets appear more prone to exploiting MMC as tacit collusion facilitating factor. Figure 3 further visualizes this result. From there we can see that the effect of MMC on price starts gradually increasing once we exclude the markets at least as concentrated as symmetric duopolies from the sample. The magnitude of the price effect of multimarket contact does not appear substantial at first glance. Indeed, doubling of the extent of MMC only increases the price by 1.2 – 2.75 percent.

Table 7 presents results of regressions estimating the determinants of HHI. We suggested earlier that a positive MMC-HHI coefficient is consistent with the tacit market sharing agreement being present. We see from the estimation results that the MMC-HHI coefficient is actually negative for the entire sample, implying that an increase in MMC leads to lower market concentration. Further investigation reveals that the relationship reverses its sign and gains statistical significance in sub-samples of less concentrated routes. The corresponding HHI cut-off, where we start observing evidence consistent with the market sharing agreements, is between 0.4 and 0.35, depending on whether MMC is treated as exogenous or endogenous (see Figure 4). The magnitude of the corresponding effect does not appear substantial. Looking at the sub-sample of markets with HHI<0.3; doubling of the extent of MMC is expected to increase HHI by mere 3.5 percent. That is, while multimarket contact does contain competition on the otherwise fragmented markets; the magnitude of the corresponding effect is not impressive.

Results of the investigation of MMC-number-of-competitors relationship, presented on Figure 5, reveal the following. When multimarket contact is treated as an exogenous variable, we appear to detect the evidence consistent with the role of MMC as an entry deterrence device. An increase in the level of multimarket contact appears to drive firms out of the markets in the year after the level of MMC has increased. This relationship does not however hold for the more competitive routes. Both fixed effects regressions treating MMC as endogenous and the Poisson regressions reverse the picture, however. Specifically, those specifications demonstrate that increased MMC increases the number of competitors the following year, unless we are dealing with competitive markets. On those more competitive routes, the relationship is either negative (in some of the Poisson regressions) or not statistically significant. Overall, with the exception of some of the Poisson regressions, these results confirm that market exits following increased multimarket contact is not what is driving the positive MMC-HHI relationship on the otherwise competitive routes; consequently, as remarked earlier, we rule out theories of entry and entry deterrence as potential alternative explanations.

To sum up, our results seems to paint the following picture. Where the market is already concentrated, airlines do not mind entering the routes where their substantial competitors (as measured by MMC) are already present. This result seems to be consistent with Bernheim and Whinston (1990) claim that market asymmetries is a factor that drives MMC as a facilitator of collusion. However, the airlines are also wary of building up their presence on the less concentrated markets, where their substantial competitors are also present. When entering a less concentrated market, an airline will pick one where it would not compete with the substantial competitors. This appears consistent with the market sharing story of Belleflamme and Bloch (2004). Our results for low concentrated markets seem to also indicate that firms consider the two anti-competitive strategies as complementary: MMC is used to charge higher prices and we have evidence consistent with market sharing behavior.

To illustrate the implications of our estimation results for the degree of competition and prices, consider the following example. Assume four airlines operating on four different markets, under the following market-sharing arrangement. On market 1, airline 1's market share is 40 percent, and the remaining 60 percent is shared equally by the other three carriers. On market 2, airline 2 is the dominant carrier, with 40 percent market share; the remaining market being equally shared by its competitors, etc. That is, HHI on each of these four markets is equal to 0.28. Next, suppose an exogenous events doubles the degree of MMC on these markets, keeping everything else constant. Our results for MMC-HHI relationship imply that this change will increase HHI by about 3.5 percent, or to about 0.29. Further suppose that this increase in HHI is driven from strengthening of the largest airline on each respective market: the share of the largest carrier increases, whereas the market shares of the other competitors decline by an equal amount. The market share reshuffling that will produce such a change in HHI is an increase of the largest carrier's market share to about 53 percent, with the decline in other three airlines' market shares to about 15.6 percent[9]. This corresponds to about 32 percent increase in the market share of the dominant firm; whereas market shares of the 'fringe' firms are reduced by about a fifth.

Coming next to the price regressions (we will use the rightmost column of Table 6 here), we conclude the following. Doubling of the extent of multimarket contact increases prices of all four airlines on all four markets by 2.75 percent. Changes in market shares imply that price charged by the dominant firm increases by additional 4.5 percent; whereas the fringe firms' prices are reduced by about 3 percent. In the end, our thought experiment of doubling the MMC on an otherwise not very concentrated market implies an increase in market concentration, and a substantial increase in the prices charged by the dominant airline. The net effect on prices charged by the fringe carriers is near zero, as the negative market share effect is cancelled out by the positive multimarket contact effect. Finally, since every airline in our example is a dominant carrier on one of the four markets; each carrier gets to charge a substantially higher price on a market it dominates without having to lower its prices on other markets.

The above example of a situation potentially leading to a sizeable increase in the dominant airline's price requires a significant increase in the level of MMC. On one hand, our estimation results suggest that any market sharing arrangements present in the industry do not appear to affect competition to a degree that should worry the policy makers. Indeed, substantial increase in the level of MMC would be required to very modestly reduce market concentration. At the same time, the very tendency for tacit market sharing behavior could send warning signals to the authorities in light of the recent consolidation events in the US airline industry, which have increased the level of multimarket contact substantially. Bilotkach (2011) demonstrates that US Airways – America West merger has resulted in softening of competition industry-wide via increased multimarket contact. The effect was admittedly short-lived; however, the merger in question was not a significant event in terms of the market shares of the partner airlines. Both

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[9] These market shares are obtained by solving $(0.4+\varepsilon)^2 + 3\left(0.2 - \frac{1}{3}\varepsilon\right)^2 = 0.29$ for ε, which is the change in the largest carrier's market share.

Delta-Northwest and Continental-United mergers, however, have a substantial potential for increasing the MMC and softening competition on the many markets, where only one-stop services are available.

V. Concluding Comments

In this paper, we offer an empirical investigation of two forms of anticompetitive behavior: i) tacit price collusion, and ii) implicit market sharing agreements. We exploit the substantial variability of MMC and market concentration in the airline industry. The specifics of the industry suggest that the relationship between multimarket contact and market concentration can be evaluated to indicate the presence of tacit market sharing arrangements. We guide the interpretation of our empirical findings in the light of Bernheim and Whinston (1990) and Belleflamme and Bloch (2004) theoretical contributions.

Our analysis of the relationship between MMC and prices yields evidence consistent with earlier findings that increased MMC leads to higher prices. We also find that more fragmented markets show evidence of a stronger effect of multimarket contact on prices.

The most novel of our results pertains to evidence consistent with the possibility of market sharing agreements on markets which otherwise appear competitive. This issue is of clear eminent importance for antitrust policy, and has not received much econometric work. The sort of market-sharing agreement which is consistent with both the structure of the airlines' networks and the role of multimarket contact in facilitating tacit collusion appears to be the one where major network carriers channel traffic within their networks in such a way that some airlines end up being dominant on one set of routes, whereas other airlines dominate a different set of markets. We further argue that the extent of multimarket contact should reinforce such tacit market-sharing arrangements for the same reason why it reinforces tacit collusion in general. The more markets are covered by the market sharing arrangements, the harsher the potential punishment for violating this tacit agreement.

The overall picture of the competition and market sharing that emerges from our data analysis is the following. The airlines reinforce their tacit collusion by building small-scale presence on the concentrated markets, where their key rivals (as measured by the extent of MMC) are present. The multimarket contact thus built-up is then used to limit the intensity of competition on less concentrated routes, as evidenced by both stronger MMC-price relationship on those markets and the quasi-market sharing arrangements we detect there. A somewhat encouraging conclusion of our study is that the extent of any tacit market sharing arrangements on the US airline markets is limited to routes which are already competitive. The magnitude of the corresponding effect is also not substantial – significant increase in the level of multimarket contact is required to generate modest increases in the level of market concentration. We however proceed to demonstrate that this modestly higher market concentration can yield significant price increase by the carrier that is dominant on the route, working via both increased multimarket contact and higher market share of the dominant carrier. We further argue that the very tendency for tacit market sharing behavior should send warning signals to the authorities in light of the recent consolidation events in the US and EU airline industry, which have increased the level of multimarket contact substantially.

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Table 1 Multimarket Contact between US Carriers

	Alaska	JetBlue	Continental	Delta	Frontier	Air Tran	Hawaiian	America West	Northwest	ATA	United	US Airways	Southwest	Midwest
American	11.50 (4.51)	17.17 (6.27)	677.17 (69.17)	1182.50 (71.38)	42.00 (20.56)	75.33 (26.09)	8.00 (2.00)	184.67 (135.15)	721.50 (96.54)	30.33 (41.07)	1071.00 (120.24)	288.33 (141.99)	445.50 (16.62)	29.50 (7.34)
Alaska	--	0.83 (1.17)	4.33 (1.51)	100.00 (15.07)	4.00 (1.55)	0.17 (0.41)	0.83 (1.60)	18.00 (3.35)	19.50 (14.90)	0.17 (0.41)	6.83 (10.96)	6.83 (10.96)	42.33 (2.25)	0.00 (0.00)
JetBlue		--	14.00 (7.90)	63.00 (28.66)	0.00 (0.00)	13.33 (10.80)	0.00 (0.00)	3.50 (3.02)	2.83 (0.98)	0.00 (0.00)	38.33 (18.24)	46.17 (24.24)	7.00 (4.56)	0.00 (0.00)
Continental			--	642.33 (76.89)	6.33 (3.56)	11.33 (7.47)	0.00 (0.00)	46.00 (35.96)	257.00 (62.66)	3.00 (3.58)	249.67 (26.16)	176.83 (30.22)	230.00 (28.50)	3.17 (0.98)
Delta				--	59.50 (36.99)	291.50 (59.71)	1.67 (0.82)	122.00 (94.26)	1047.83 (137.34)	23.33 (28.29)	1142.83 (81.21)	1162.67 (170.91)	421.83 (21.36)	19.67 (3.88)
Frontier					--	0.00 (0.00)	4.33 (3.93)	13.17 (11.46)	48.17 (26.35)	0.67 (0.52)	127.33 (67.54)	11.33 (18.49)	43.67 (23.34)	2.00 (1.10)
Air Tran						--	0.00 (0.00)	0.50 (0.84)	98.83 (24.67)	3.50 (3.33)	52.00 (14.59)	129.83 (43.97)	34.00 (15.80)	7.83 (6.62)
Hawaiian							--	1.17 (2.04)	5.00 (1.67)	5.00 (1.41)	26.17 (5.71)	1.50 (2.51)	(0.00) (0.00)	0.00 (0.00)
America West								--	53.17 (39.85)	1.67 (2.07)	240.50 (167.40)	25.50 (34.89)	112.83 (84.42)	1.00 (0.89)
Northwest									--	33.83 (47.70)	1048.17 (120.33)	382.67 (36.77)	165.50 (6.44)	88.33 (8.94)
ATA										--	32.33 (39.89)	10.17 (13.24)	10.00 (5.29)	0.50 (0.84)
United											--	484.17 (171.42)	258.83 (44.61)	63.17 (5.08)
US Airways												--	217.17 (126.11)	3.67 (1.21)
Southwest													--	7.33 (5.20)

Table 2 Descriptive Statistics for Price

	2003	2004	2005	2006	2007	2008	All
American	218.75 (68.91)	221.51 (65.97)	221.85 (65.58)	240.12 (70.84)	244.84 (73.06)	262.43 (79.08)	234.49 (72.32)
Alaska	201.21 (80.34)	203.17 (79.10)	218.02 (79.25)	242.30 (86.56)	245.19 (92.60)	271.10 (110.36)	230.89 (92.53)
JetBlue	159.82 (49.22)	152.60 (40.45)	161.42 (47.27)	169.41 (50.09)	174.59 (46.56)	185.93 (52.31)	171.37 (49.54)
Continental	222.72 (72.98)	224.74 (76.40)	234.63 (75.23)	253.31 (80.78)	257.40 (92.81)	270.47 (99.48)	243.15 (84.57)
Delta	214.26 (65.50)	212.10 (62.00)	215.01 (55.02)	241.77 (64.47)	246.27 (72.36)	254.77 (75.69)	229.98 (68.20)
Frontier	148.43 (22.23)	154.30 (19.62)	174.50 (27.35)	183.94 (27.80)	186.11 (34.79)	190.56 (39.33)	179.85 (34.78)
Air Tran	137.68 (26.06)	139.38 (24.93)	145.33 (25.31)	145.47 (29.03)	138.50 (28.13)	162.21 (30.90)	146.16 (29.37)
Hawaiian	243.31 (96.96)	256.48 (101.76)	273.84 (101.05)	279.43 (107.12)	269.33 (108.65)	333.71 (123.51)	277.12 (110.24)
America West	199.16 (45.87)	191.77 (39.90)	211.62 (47.27)	255.83 (73.56)	256.81 (99.61)	---	215.75 (60.87)
Northwest	206.44 (63.66)	213.10 (63.84)	219.36 (59.64)	235.62 (70.55)	234.92 (76.23)	247.74 (84.03)	225.19 (70.98)
ATA	151.07 (35.19)	148.54 (37.18)	172.62 (71.38)	214.20 (72.46)	225.54 (87.07)	219.43 (55.44)	160.08 (51.71)
United	232.58 (73.07)	226.95 (68.37)	236.06 (67.39)	256.78 (73.15)	260.29 (78.25)	277.79 (89.82)	248.22 (77.35)
US Airways	200.15 (54.97)	189.50 (52.34)	190.85 (48.86)	227.98 (54.91)	238.94 (66.69)	251.48 (73.24)	220.61 (65.68)
Southwest	157.52 (43.47)	152.22 (38.26)	161.06 (42.65)	175.91 (43.22)	178.72 (44.14)	194.20 (46.07)	171.38 (45.59)
Midwest	181.25 (27.96)	177.20 (26.87)	172.51 (20.00)	190.19 (27.58)	189.48 (26.94)	199.80 (26.73)	185.64 (27.65)
All	210.59 (70.39)	209.15 (68.80)	214.15 (67.25)	236.50 (76.25)	238.59 (81.87)	251.15 (88.16)	226.68 (77.52)

Note: reported values are non-weighted averages, with standard deviations in parentheses.

Table 3 Descriptive Statistics for AMMC

	2003	2004	2005	2006	2007	2008	All
American	1698.1 (914.0)	1666.3 (889.3)	1575.8 (890.7)	1575.9 (868.4)	1461.9 (816.7)	1353.6 (783.3)	1558.6 (870.6)
Alaska	35.2 (43.4)	30.6 (37.6)	37.9 (45.9)	49.8 (57.7)	49.9 (56.2)	46.9 (52.7)	41.9 (50.1)
JetBlue	36.0 (28.7)	41.5 (28.3)	34.5 (26.0)	65.5 (49.5)	107.1 (75.1)	88.4 (69.5)	73.1 (63.7)
Continental	925.9 (532.2)	871.0 (507.6)	873.9 (532.4)	1000.1 (596.8)	915.6 (512.2)	848.4 (440.5)	909.4 (528.7)
Delta	1620.0 (1016.6)	1644.7 (1055.8)	1653.4 (1029.8)	1694.2 (979.6)	1809.9 (969.4)	1759.8 (927.6)	1694.7 (1001.2)
Frontier	44.0 (19.2)	82.4 (35.9)	152.0 (57.3)	148.0 (67.1)	147.9 (67.3)	256.1 (103.3)	169.7 (99.6)
Air Tran	252.7 (103.4)	241.0 (104.9)	263.8 (128.5)	320.2 (146.7)	350.1 (171.1)	422.1 (209.9)	322.3 (170.5)
Hawaiian	22.4 (17.1)	21.2 (16.8)	22.1 (17.2)	12.3 (12.5)	10.3 (11.1)	11.6 (11.7)	16.5 (15.4)
America West	410.7 (223.4)	441.7 (232.5)	455.4 (240.1)	461.3 (237.1)	124.9 (35.0)	---	430.6 (237.6)
Northwest	1549.9 (856.5)	1614.1 (896.7)	1561.6 (886.8)	1283.7 (747.1)	1210.8 (699.2)	1161.3 (678.7)	1410.9 (826.0)
ATA	144.7 (100.0)	133.0 (92.5)	14.0 (11.7)	8.2 (5.9)	15.1 (9.9)	6.4 (2.7)	113.7 (100.1)
United	1677.1 (911.2)	1676.9 (951.2)	1605.5 (925.9)	1527.3 (899.5)	1545.4 (872.3)	1459.4 (812.3)	1582.6 (900.6)
US Airways	1047.5 (575.5)	1000.0 (568.1)	882.7 (531.1)	915.6 (534.2)	1298.4 (714.2)	1335.7 (777.0)	1113.3 (668.3)
Southwest	471.8 (375.4)	468.1 (379.2)	497.7 (395.7)	482.0 (405.0)	508.8 (423.9)	501.0 (411.7)	489.4 (400.6)
Midwest	107.9 (56.1)	112.7 (53.2)	126.2 (64.5)	101.9 (59.3)	93.8 (59.9)	126.2 (71.9)	112.0 (62.7)
All	1299.8 (954.5)	1297.8 (977.2)	1242.7 (956.4)	1204.8 (908.4)	1248.0 (906.3)	1195.9 (871.1)	1248.3 (930.7)

Note: reported values are non-weighted averages, with standard deviations in parentheses.

Table 4 Descriptive Statistics for AvgMMC

	HHI					
	[0, 0.2)	[0.2, 0.4)	[0.4, 0.6)	[0.6, 0.8)	[0.8, 1)	All
2003	1998.9 (799.57)	1455.714 740.8364	811.66 (573.19)	354.55 (482.57)	1.423 (42.40)	984.36 (848.47)
2004	2010.2 (806.29)	1451.159 (763.31)	778.43 (566.00)	311.18 (450.09)	0.439 (13.24)	976.43 (863.98)
2005	1840.3 (760.74)	1405.3 (772.04)	719.68 (546.71)	290.99 (418.60)	0.677 (12.77)	930.26 (842.35)
2006	1694.4 (734.22)	1343.4 (741.36)	704.88 (517.30)	268.45 (408.71)	0.893 (26.38)	901.22 (804.65)
2007	1778.3 (715.02)	1379.8 (716.70)	757.31 (563.66)	340.22 (470.28)	0.249 (5.111)	944.61 (809.50)
2008	1765.7 (692.18)	1306.6 (686.39)	742.77 (551.39)	351.51 (479.14)	0.598 (10.80)	905.17 (775.27)
All	1844.9 (760.93)	1389.8 (739.02)	753.09 (554.65)	319.38 (453.36)	0.716 (22.30)	940.47 (825.36)

Note: reported values are non-weighted averages, with standard deviations in parentheses.

Table 5 Descriptive Statistics for HHI

	MMC, market level measure				
	[0, 1000)	[1000, 2000)	[2000, 3000)	[3000, 4000)	All
2003	0.606 (0.235)	0.387 (0.139)	0.279 (0.085)	0.218 (0.051)	0.473 (0.228)
2004	0.602 (0.234)	0.381 (0.136)	0.272 (0.080)	0.220 (0.054)	0.471 (0.228)
2005	0.592 (0.236)	0.372 (0.137)	0.276 (0.081)	0.228 (0.056)	0.468 (0.229)
2006	0.571 (0.236)	0.345 (0.127)	0.252 (0.079)	0.240 (0.046)	0.463 (0.231)
2007	0.573 (0.231)	0.345 (0.131)	0.264 (0.080)	0.203 (0.031)	0.463 (0.229)
2008	0.568 (0.232)	0.342 (0.127)	0.251 (0.078)	0.183 (0.023)	0.465 (0.229)
All	0.584 (0.234)	0.363 (0.134)	0.267 (0.081)	0.224 (0.052)	0.467 (0.229)

Note: reported values are non-weighted averages, with standard deviations in parentheses.

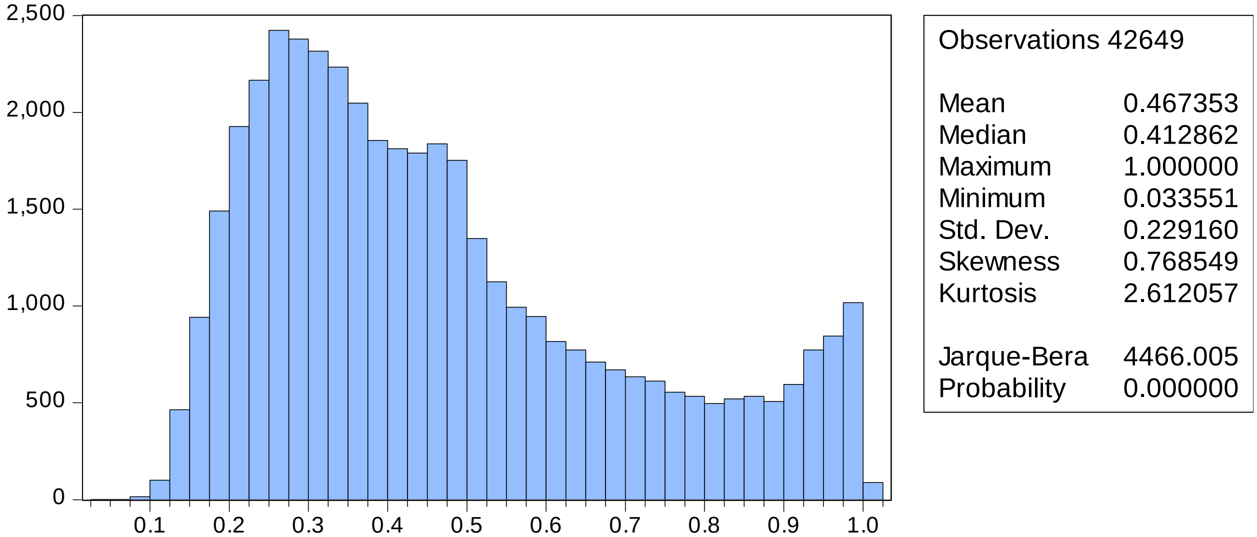


Figure 1 Histogram of HHI, Market-Level Observations

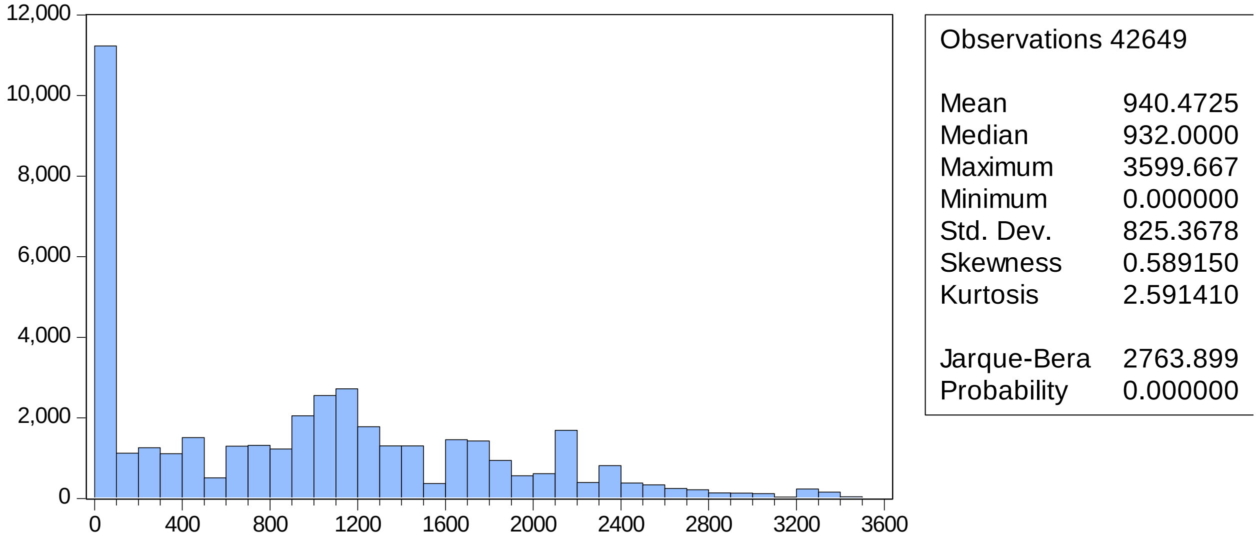


Figure 2 Histogram of MMC, Market-Level Observations

Table 6 Estimation Results, Price Regressions

	Entire Sample	HHI<0.7	HHI<0.4	HHI<0.3
Constant	7.8283** (0.9902)	7.1147** (1.0543)	9.2481** (1.3605)	10.0377** (1.8825)
Log(Market Share)	0.0976** (0.0027)	0.1000** (0.0027)	0.1203** (0.0035)	0.1412** (0.0047)
Log(MMC)	0.0119** (0.0007)	0.0122** (0.0009)	0.0168** (0.0020)	0.0274** (0.0038)
Log(Population)	-0.0938* (0.0527)	-0.0743 (0.0541)	-0.1777** (0.0665)	-0.1928** (0.0866)
Log(Wage)	-0.1606** (0.0804)	-0.0923 (0.0875)	-0.1827 (0.1150)	-0.2656 (0.1662)
Adjusted R-squared	0.8034	0.7947	0.7920	0.7921
Number of Observations	99,322	91,057	62,790	40,600
Markets Included	8,141	7,113	4,839	3,165

Notes:

1. Dependent variable is the natural logarithm of price.
2. Sub-samples include all the markets with HHI lower than the noted cut-off value.
3. Estimation methodology – two-stage least-squares with market fixed effects.
4. Standard errors, robust to heteroscedasticity across and autocorrelation within cross-sections, are in parentheses.
5. Year and airline indicator variables are included into each regression, but not reported.
6. Conventional notation for statistical significance is used: * - 10%; ** - 5%

Table 7 Estimation Results for HHI-MMC Relationship

	Entire Sample		HHI<0.7		HHI<0.4		HHI<0.3	
	MMC Exogenous	MMC Endogenous	MMC Exogenous	MMC Endogenous	MMC Exogenous	MMC Endogenous	MMC Exogenous	MMC Endogenous
Constant	2.9379** (0.8743)	2.9968** (0.8750)	4.7060** (1.0471)	4.7381** (1.0477)	4.5523** (1.3307)	4.5534** (1.3311)	4.2702** (1.7907)	4.272** (1.7887)
Log(MMC)	-0.0204** (0.0007)	-0.0226** (0.0008)	-0.0083** (0.0010)	-0.0098** (0.0010)	0.0056* (0.0034)	0.0055 (0.0043)	0.0227** (0.0103)	0.0356** (0.0172)
Log(Population)	-0.2080** (0.0485)	-0.2090** (0.0485)	-0.2397** (0.0557)	-0.2408** (0.0557)	-0.2281** (0.0686)	-0.2281** (0.0686)	-0.2743** (0.0857)	-0.2737** (0.0858)
Log(Wage)	-0.0633 (0.0689)	-0.0695 (0.0689)	-0.2836** (0.0835)	-0.2856** (0.0835)	-0.3465** (0.1071)	-0.3465** (0.1072)	-0.2599* (0.1465)	-0.2714* (0.1469)
Adjusted R-squared	0.9197	0.9197	0.8651	0.8651	0.7757	0.7757	0.6963	0.6959
Number of Observations	41,718		34,253		20,014		11,713	
Markets Included	8,126		7,113		4,839		3,165	

Notes:

1. Dependent variable is the natural logarithm of market-level HHI
2. Sub-samples include all the markets with HHI lower than the noted cut-off value
3. Estimation methodology – FGSL or two-stage least-squares with market fixed effects, with MMC instrumented via market players' network size.
4. Standard errors, robust to heteroscedasticity across and autocorrelation within cross-sections, are in parentheses
5. Year and airline indicator variables are included into each regression, but not reported
6. Conventional notation for statistical significance is used: * - 10%; ** - 5%

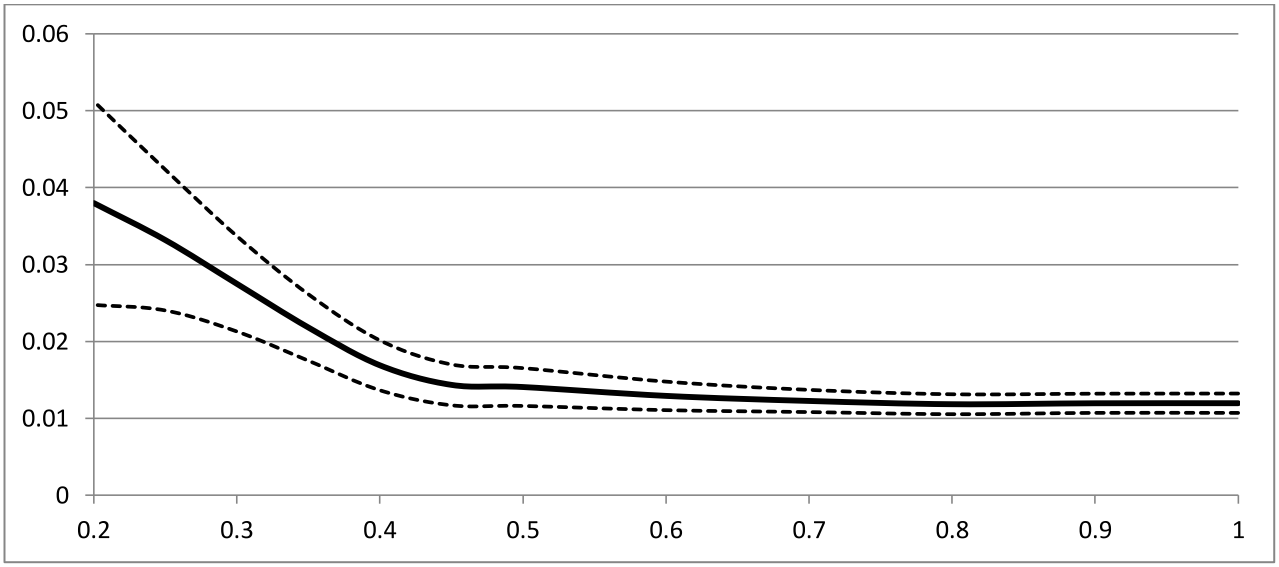
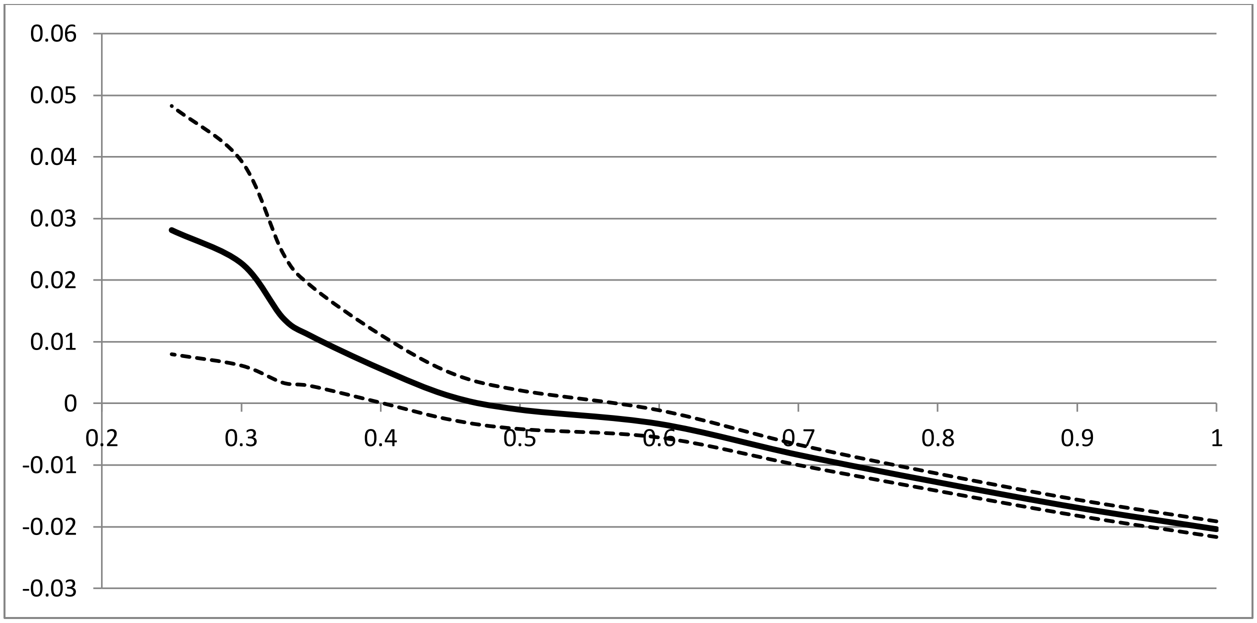
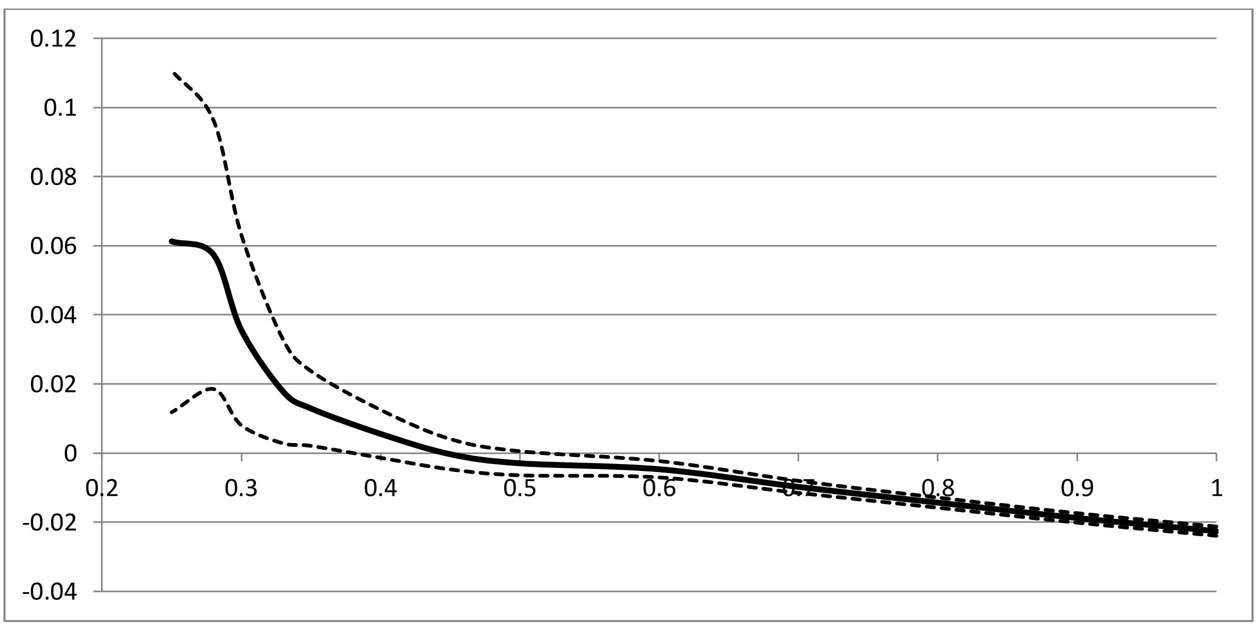


Figure 3 Log(AMMC) coefficients in price regressions for different HHI cutoffs

Note: This Figure presents log(MMC) coefficients and 95 percent confidence intervals on a series of regressions, similar to those reported in Table 6.



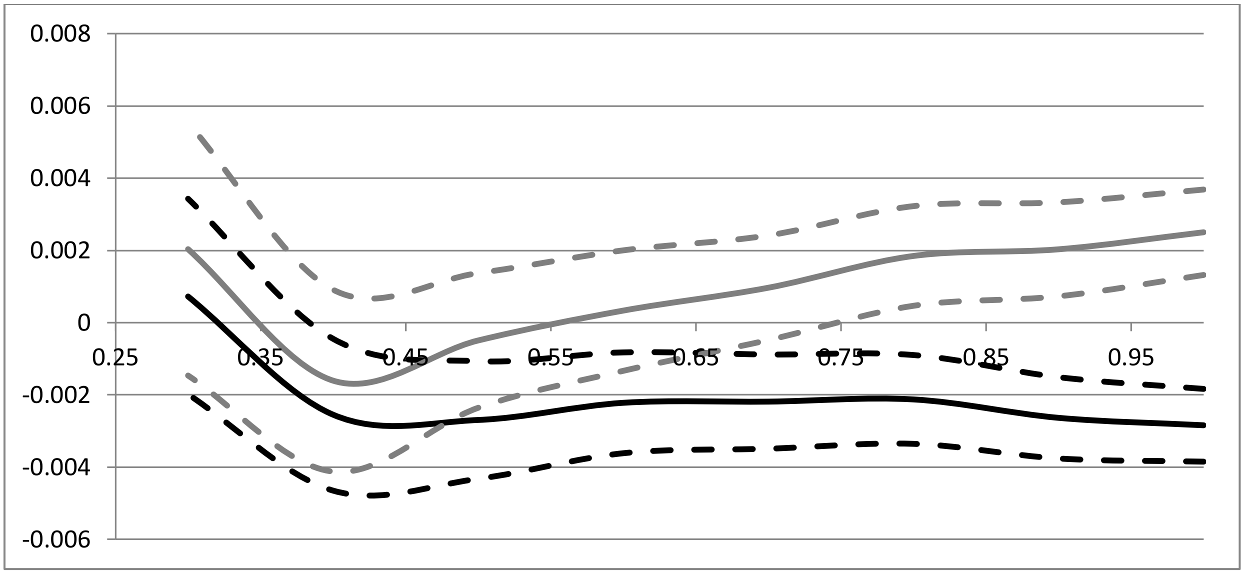
(a) MMC is exogenous



(b) MMC is endogenous

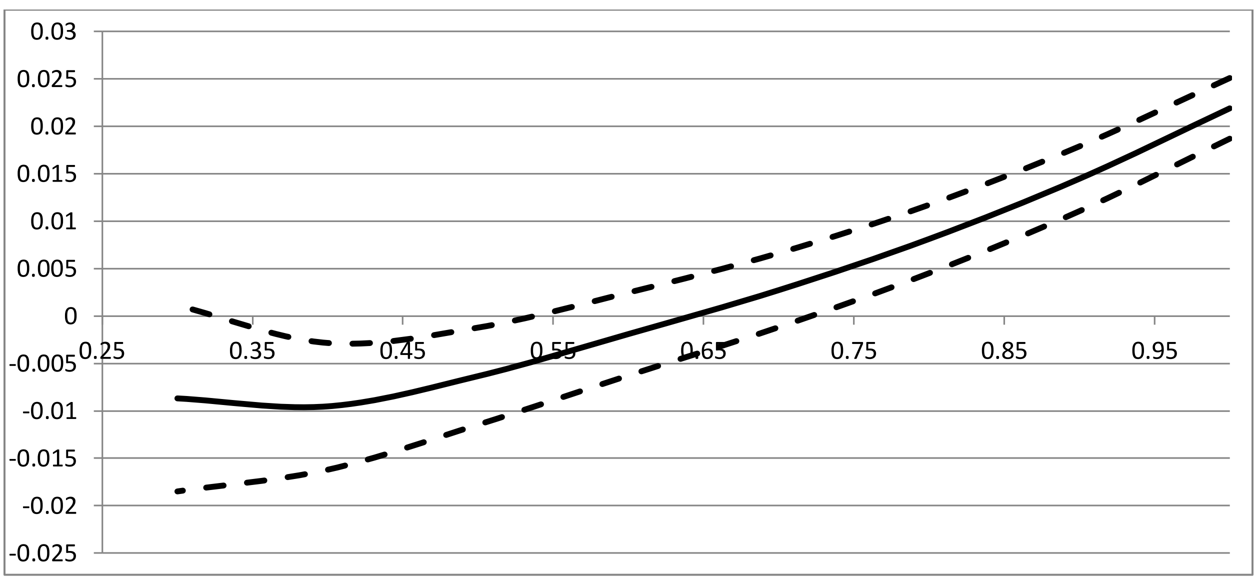
Figure 4 MMC-HHI relationships for various HHI cut-offs

Note: This Figure presents log(MMC) coefficients and 95 percent confidence intervals on a series of regressions, similar to those reported in Table 7.



(a) Fixed Effects Regressions

Note: This panel presents logarithm of lagged MMC coefficients and 95 percent confidence intervals on a series of fixed effects regressions with the logarithm of the number of competitors as the dependent variable, in a similar fashion to those reported in Figures 3 and 4. Darker curves correspond to specifications treating MMC as exogenous; lighter lines are based on regressions treating MMC as endogenous.



(b) Poisson Regressions

Note: This panel presents logarithm of lagged MMC coefficients and 95 percent confidence intervals on a series of Poisson regressions with the logarithm of the number of competitors as the dependent variable.

Figure 5 Relationship between MMC and number of competitors