

Price wars and price collusion in China's airline markets

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Abstract

In the absence of an effective antitrust law, both fare wars and price collusion have been pervasive in China's airline markets, causing concern for both airlines and consumers. A study of monthly airfare data from 2002 to 2004 confirms that fare wars occur periodically, as well as price collusion. Both tend to be short-lived. The fact that collusion is more likely to occur in January and April when demand is high, as revealed by China Eastern's and China Southern's price-war and collusion models, has been confirmed by interview information obtained from the airlines' sales managers. However, there is also evidence in these models suggesting that collusion can be more easily formed when demand is low. High airport concentration measured by the HHI may facilitate collusion in certain circumstances, but it may also lead to more price wars under other conditions. Concentration in both airports and routes does not appear to systematically affect the occurrence of fare wars and collusion in all the models estimated. We also reject the possibility that mutual forbearance due to multimarket contact plays any important anti-competitive role in China's airline markets.

Keywords: Price Wars, Collusion, Airline Market, China

JFL classification: L11, L13, L93

Authors' Accepted Version of: Zhang, Yahua and Round, David K. (2011) *Price wars and price collusion in China's airline markets*. International Journal of Industrial Organization, 29 (4). pp. 361-372. doi: 10.1016/j.ijindorg.2010.07.005

1. Introduction

Price wars in airline markets around the world have been extensively observed and reported on by the press. Economic theories have modelled the causes and consequences of price wars. The conventional reason advanced for the outbreak of a price war is the breakdown of collusion. As collusion is an illegal activity in many countries, it is not easy to thoroughly document such behaviour. It is also hard to determine when a price war actually starts, and how and when it comes to an end, and for what reasons.

Airfare collusion in China is not a secret and has been widely reported by newspapers.¹ For example, in a report by Chen (2006) titled “Price Union Suspected to have Pushed up Airfare in this Low Season” in *Information Times* (27/03/2006), Air China, China Southern and China Eastern admitted to the reporter that they did “hold talks” from time to time to prevent airfares sliding down to train fare levels.² As a result, since the deregulation of airline prices in 1997, Chinese passengers have constantly witnessed overnight across-the-board increases in airfares. In one period, passengers enjoy very low prices, while in another they have to pay prices close to the full published fares, with little or no discount being available. The absence of an effective antitrust law means that such collusive behaviour faces no threat of prosecution, as long as the airfare is not more than the published full fare. However, in the years since price deregulation, for most of the time passengers have enjoyed lower fares than before, thanks to fierce competition among airlines.

The joint setting of higher prices has been common, but this collusive activity by airlines does not simultaneously happen on all routes, and usually does not last for long. More frequently, the price agreements collapse and surprisingly low prices ensue. Price wars could be discovered in almost all city-pair markets, and led to the consolidation of the state-owned trunk airlines in October 2002. One of the main aims of these amalgamations, as seen by the General Administration of Civil Aviation of China (CAAC) and the relevant merging parties, was to reduce unnecessarily destructive competition and produce a more “orderly” market (see Zhang and Round (2008) for more details).

Nevertheless, price wars have still occurred from time to time since the mergers in 2002, and from route to route, partly reflecting the fact that long-lasting effective

¹ For a collection of China’s air price discount reports from 2000 to 2006, see the Civil Aviation Net of China <http://www.carnoc.com/>. Local newspapers across the country have extensively reported the dramatic airfare changes associated with local cities.

² After being discussed for more than 10 years, China’s antitrust law was passed in 2007 and came into effect from 1 August 2008. Although not targeted by any laws before this, airlines did not appear to want to admit to their price-fixing activities. Therefore, they avoided using expressions such as “price fixing” or “price collusion”, instead frequently using the neutral expression “price union”.

collusion is notoriously difficult to achieve. For example, *Youth Times* (2004) reports that Air China offered an 80% discount, or 350 yuan (US\$44) fare from 15 to 16 December 2004 on the Shenzhen–Beijing route, whereas previously the discount offered was only 30% at most, and the fare was rarely less than 1000 yuan (US\$125). China Southern and Shenzhen Airlines matched this low price a few hours later and all flights in the following days were soon fully booked. However, this short price war ended days later after an “emergency meeting” between the sales managers of China Southern and Air China. All airlines’ prices rose to around 50% (875 yuan or US\$109) of the normal price on 19 December 2004. This pattern of behaviour has been repeated on many city-pair routes from time to time in China.

Price fixing and price war dramas in China’s airline markets provide an ideal opportunity to study collusion and price war issues. Although there have been a small number of empirical studies on airfare wars which will be reviewed below, research with convincing evidence into collusive activities remains sparse due to the illegal nature of collusion and the unavailability of data for the airline industry. What differentiates our study from previous studies are its unique data sets and our accessibility to airline staff to obtain first-hand opinions on our results and to discover information that cannot be revealed by the data alone. Accordingly, this paper seeks to discover the patterns of price wars and collusion in China’s airline markets, and to estimate the conditions that facilitate the two phenomena. In the next section, we will briefly mention the theoretical models relevant to collusion and price wars. From a review of the empirical literature on airline collusion and price wars, we will discuss the identification of price wars and price collusion in section three. Section three also provides the data and model specification using the factors expected to contribute to these two types of extreme pricing behaviour. Section four will analyse the results, and conclusions will be drawn in section five.

2. Theoretical Models of Collusion and Price Wars

The prominent collusion and price-war studies include the seminal work of Stigler (1964) and that of game theorists such as Green and Porter (1984), Abreu, Pearce and Stacchetti (1986), Haltiwanger and Harrington (1991), and Slade (1989). Most of the game theoretical works have modelled the effect of a change in demand on the breakdown of a cartel. Porter’s (1983) analysis of the Joint Executive Committee (JEC) cartel contends that firms with imperfect monitoring can only observe their own output and industry-wide price collusion. The trigger price might be activated by an unexpected low demand shock or by cheating. Either could result in a period of punishment in which each firm produces at Cournot–Nash levels and then resumes a collusive phase. The periodical price wars are a result of the firms’ inability to perfectly monitor all the other members’ behaviour, and are an information cost that a cartel must bear. Price wars here should not be seen as the end of the cartel, but rather they help the cartel to regain stability. In this model, price wars are thought to be more

likely to happen during economic downturns. Ellison (1994) re-examined the JEC cartel and provided further findings in support of the Green and Porter theory.

Rotemberg and Saloner (1986) show that if demand shocks are observable, price wars could happen in an expanding economy due to the lure of the benefits of cheating in high demand periods compared with the possible costs of punishment. If the cartel could flexibly adjust the agreed-upon price in response to increased demand (by lowering prices in booms), cheating would not happen and the cartel would not break down. Therefore, price collusion never breaks down, but we can still observe fluctuations in cartel prices. This model provides a situation where a competitive outcome occurs in an expanding economy. The JEC case was also considered by the authors who concluded that price wars occurred in winter periods when the Great Lakes are frozen and in the years when grain production is high.

A theory focused on entry or strategic entry deterrence by incumbents was developed by Klemperer (1988, 1989), who acknowledged the existence of the substantial costs of switching faced by consumers. To attract consumers, a new entrant will provoke a price war by providing a lower price to temporarily compensate consumers for their switching costs. Alternatively, a lower price can be seen as an attempt to influence consumers' expectations, persuading them to switch to an alternative firm by giving up their current preference. Once an entrant has locked in its new consumers, the price war ends and normal prices resume. Unfortunately for our study, there is not a sufficient number of new entrants in the data sets, and so it is impossible to examine systematically the effects of entry or entry deterrence on pricing.

Another relevant model for the airline industry regarding the breakdown of collusion is presented by Staiger and Wolak (1992), who support the view that low demand leads to a breakdown of collusion resulting from the emergence of excess capacity. The war might be "mild" or "severe", depending on the amount of excess capacity. The larger the excess capacity, the more severe the price wars. It seems that the airlines in China, as in other countries, have historically operated with chronic excess capacity,³ and this continues to be the case. Therefore it is expected that price wars will not be eliminated any time soon.

These theoretical models together with other collusion theories have provided an insightful basis on which to study collusive prices and price warfare. Empirical findings in this area to date are of limited relevance to this study because many of them are derived from industries that differ significantly from the airline industry. Therefore, we confine our attention mainly to the empirical studies on airline industries in other countries, and develop from them our price war and collusion models.

³ Tirole (1988) notes that excess capacity might be used as a strategic device to deter entry.

3. Definition of price wars and price collusion, model and data

The identification of a price war is always problematic, owing to the subjectivity and arbitrariness of the process. Heil and Helsen (2001) described a set of qualitative conditions that could be used to identify a price war, which include: first, the actions and reactions largely involve the competitor instead of the consumer; second, pricing interplay is undesirable for the competitors; third, no competitors deliberately ignite a price war; fourth, the pricing behaviour breaches industry norms; fifth, the pricing interaction happens at a much quicker rate than previous interactions; finally, the direction of the pricing is downward but such pricing behaviour is not sustainable. Most of these conditions are easy to observe and, in fact, most reports in the media on price wars are based on observations of these conditions.

Ross (1997) pointed out that the problem of defining price wars in the US cannot be mitigated by the wealth of data available, because the quarterly nature of the data from the Origin and Destination Survey in the US does not allow researchers to observe instantaneous changes in prices. Morrison and Winston (1996) claimed that 90% of the fare wars in their samples lasted two or fewer quarters, with an average of 1.8 quarters on the assumption that any rise in the average fare indicated the end of a war, which means that quarterly data are enough to capture fare wars. However, this claim may not be justifiable because it ignores price wars that last for just days, a few weeks or a month. These short-lived wars would not be revealed by quarterly data. To avoid the problem arising from quarterly data, Busse (2002) identified price wars according to reports in the press. The use of monthly price data in our study does not entirely eliminate the problem as it is still not possible to identify all short-lived price wars that stopped within days. Such short price wars are pervasive in China's airline markets because the explicit or implicit coordination mechanisms among airlines do not let any price war last too long. However, by using monthly data, it is believed that most major price wars with substantial drops in prices are covered.

Following Morrison and Winston's definition of a price war, the average price of a given month is compared with that of the previous month. If there is a price drop from the previous month to the current month of more than 20%, a price war is arbitrarily said to have occurred in that market. Instead of using their signal that the average fare rises by any amount to identify the end of a price war, the end of a price war in this study is defined as a period when an increase in the price by 5% (from the previous month) is observed in a particular market.

Ross (1997) raised another problem in identifying price wars, namely, whether it is better to compare a given quarter's price with that of the previous quarter, or with the price in the same quarter in the previous year. The author argued that given the seasonal fluctuations occurring in the airline industry, the annual comparison is more appropriate. However, this might not be appropriate in our case where mergers caused lower price levels in many airline markets in the years following the mergers, as

revealed in Zhang and Round (2009a). Therefore, we prefer the approach used by Morrison and Winston (1996).

Levenstein and Suslow (2006) pointed out that most modern case studies surprisingly have paid little attention to evaluating the success of cartels, or broadly, of any forms of collusion. They surveyed a few studies and reported the existence of three ways to measure a successful cartel: the use of price to measure success, a comparison of good times against price wars to measure success, and using duration as a proxy for success.

Similarly to the definition of a price war, we define the formation of a collusive price agreement as a situation when the average airfare in a given month rises by 20% from the previous month.⁴ Such collusive conduct is assumed to continue to be successful until the average airfare drops by 5% or more from the previous month. Again, this definition of collusion is subject to arbitrariness. In fact, Levenstein and Suslow (2006) mentioned that many cartels are formed following a drop in prices, which means that cartel prices might be lower, or at least not higher, than those in the pre-cartel period. Clearly, our definition of collusion cannot capture the situation where the airlines set collusive price levels at a moderate level, i.e., neither extremely high nor extremely low. It should also be recognised that falling prices may not necessarily mean the failure of a price agreement. They may be the result of independent responses to falling demand.⁵

However, the lack of effective antitrust laws can in fact justify the appropriateness of our definition of price collusion in the context of China's airline markets. The reason for this is that once an agreement has been reached, the price could be expected to go up quickly, and once a member has been detected cheating, average prices will drop quickly to match these lower fares. The carriers do not have to disguise their price cooperation by formulating a moderate agreed-upon price. Therefore, our definition of price collusion is likely to capture most of the important collusive agreements that

⁴ Feuerstein (2005) noted that '[a] possible indicator that could make antitrust authorities suspicious that collusion takes place are substantial price movements that do not seem to have an explanation in cost or demand shifts. We believe that a 20% change in price could be seen as 'substantial'.

⁵ We acknowledge that the change in prices might reflect the mingling of the shift in demand and the engagement of collusion. However, as will be discussed later in this paper, our interview information revealed that it was a common practice for the airlines to hold talks before the advent of the peak season. In this sense, our definition of price collusion does not lose its accuracy. It might also be argued that fluctuations in prices are a response to changes in costs. However, this concern can be dismissed in our case as an examination of the airlines' financial reports reveals that most costs were relatively stable during our study period 2002-2004. The only possibly significant shock to this industry might have been the rise in fuel prices. However, fuel prices only started to rise significantly in the second half of 2004 and so this increase should not pose a serious problem for assessing competitive behaviour in the period 2002-2004, even without considering that the airlines could hedge their fuel costs.

lead to dramatic changes in airfares in China. In addition, given the ease of engaging in price agreements, communication between airlines could be engaged in on a day-to-day basis, either formally or informally. Even before the beginning of peak seasons, it was common for meetings to be held to discuss pricing issues or for the airlines to tacitly follow the dominant airline's pricing strategy, which means that any significant changes in prices were closely associated with the establishment or breakdown of a formal or informal agreement. Figure 1 plots the airfares on the route from Guangzhou to Hefei for the period 2002 to 2004, giving a pictorial example of how price wars and collusion are identified. Based on our definitions, the periods in which price wars and collusion took place are labelled, with the troughs occurring in November 2002, July 2003, August 2003 and March 2004 representing the war periods,

A probit equation is employed for the price-war model. The probit model is based on our collusion definition in which the dependent variable takes the value of 1 for successful price collusion in a given month in a particular market, and 0 otherwise. Based on the theoretical insights into price wars, as well as findings in previous studies, a number of factors that might induce price wars in China's airline markets will be included as independent variables. As a price war is the counterpoint of price collusion, the same set of factors is also used to investigate the occurrence of price collusion. We also discussed these determinants with some major Chinese airlines' sales managers in Shanghai and they agreed on the relevance of these factors to price wars.⁶ To better understand our estimation results, we also discussed our findings with the marketing staff of several airlines based in Shanghai, and they largely agreed with our interpretations.

The fare data used for this article came directly from two major Chinese airlines, China Eastern and China Southern. The route-level data include average airfares, and the number of passengers carried by each of the two airlines on a given route for a given month from January 2002 to December 2004. The data were reported as directional, which means that each of the pair of route directions can be treated as a separate market. In October 2002 the Air China, China Eastern and China Southern groups were formed from takeovers of several other relatively inefficient carriers. The data sets from China Eastern and China Southern thus enable us to examine the price wars and collusion before and after the consolidations.

⁶ The interviews were part of the project examining market power issues in China's airline market. Before interviewing the sales managers, an email stating the purpose of the interview and the interview questions were sent to them, with the assurance that their identities would remain anonymous. Six airlines' station managers or sales staff accepted the interview in 2005. These six airlines included the major airlines as well as some local airlines. Most of the interviewees frequently engaged in regular meetings with their counterparts from other airlines to discuss all relevant airlines issues, including pricing.

Due to data unavailability, we cannot include in our study all the routes on which the two airlines operated. The final data sets contain 113 markets for China Eastern and 76 for China Southern. Some of these markets lack information for a few periods because of service suspension on some routes from time to time, or due to statistical problems.

Independent Variables

A framework for price wars was developed by Heil and Helsen (2001), which, they argue, provides a guideline for researchers to empirically test for the existence of price wars. Such a framework consists of market conditions, firm characteristics, product attributes and consumer behaviour, all of which are conducive to the emergence of price wars. The conditions that facilitate price wars can also be seen in Morrison and Winston (1996), in which they categorised the effects of these conditions into two groups: external effects and internal effects. Internal effects come from the characteristics of firms and the routes on which they operate, the firms' reputations, financial conditions and so on, whereas the external economic effects are caused by fluctuations in the economy that influence demand and supply. The external effects also include seasonal and temporal influences as well as uncertainty. Busse (2002) has emphasised the effect of the financial characteristics of airlines on the occurrence of price wars.

Naturally we cannot include all the variables used in previous literature due to the unavailability of some data. In particular, given that this study involves airline mergers, we pay special attention to the market structure and multimarket contact variables that are most likely to have been affected by the 2002 mergers.

Market concentration variables

Stigler (1964) first explored the factors that facilitate effective collusion. He concluded that concentrated markets are more likely to produce cooperative outcomes than less concentrated ones, as cheating can be more easily detected. It is also considered that the gain from cheating is smaller in a concentrated market. In an airline market, both route concentration and airport concentration can be expected to influence pricing behaviour. It is expected that price wars are less likely to erupt in a concentrated market. Concentration can be measured by either market share or the Herfindahl–Hirschman Index (HHI).

The route market share for an airline can be calculated from information on available seat numbers published in the *Timetable for Chinese Air Carriers*, issued by the CAAC Chinese Air Carrier Timetable Press every March and October, and from the frequency of each airline and the type of aircraft used for each flight.

Similarly, airport market share is measured by using the airline's total flight share out of the airport (to any destination), as suggested by Brueckner (2002). In China the market share of a particular airline at the departure airport is more relevant to airfare pricing, given that the sales managers of many cities have been empowered to closely follow rivals' pricing strategies. Therefore, only the airport market share of a carrier at the departure airport is included in the airfare equation.

Multimarket contact

One salient feature of China's airline industry in the post-merger period is the greatly enhanced multimarket contact of the big three airlines. The concept of multimarket contact, a measure of the situation where the same firms compete in many markets, can be traced back to Corwin Edwards (1955). Multimarket contacts give firms familiarity with the strategies of their rivals and facilitate their tacit coordination and mutual understanding (Scott 1993; Baum and Korn 1996). One of the notable theoretical works on multimarket contact by Bernheim and Whinston (1990) supports the view that mutual forbearance might exist among firms with multimarket contacts. Evans and Kessides (1994) and Singal (1996) find consistent empirical evidence that endorses the mutual forbearance hypothesis as being relevant to the airline industry. However, other empirical studies report contrary results. Morrison and Winston (1996) and Sandler (1998) find that higher multimarket contact leads to intense price competition in the US airline market.

Multimarket contact has been measured by a variety of methods. Following Heggstad and Rhoades (1978) and other contributions to the multimarket contact literature (Jans and Rosenbaum 1995; Evans and Kessides 1994; De Bonis and Ferrando 2000), a contact matrix was constructed to measure how many times an airline meets other airlines for each of the sample routes in each period of analysis. All the airlines present during 2002 to 2004 were included. We refer to the previously-mentioned literature for details on the construction of the variable (for example, Waldfoegel and Wulf 2006).⁷ As before, the domestic timetables were used to check the number of times the airlines met each other on each route for each time period.

Symmetry

Symmetry can refer to different competition dimensions including market shares, number of varieties in the product portfolio, cost structure and productive capacities. These dimensions exercise an influence on collusion to varying degrees across

⁷ A simple example can illustrate the idea. Consider a city-pair route on which three airlines A, B and C provide services. Assume that Airline A meets B 40 times and C 40 times, while B meets C 10 times in all the markets, then the total number of meet times for the three airlines is $40+40+10=90$. The number of possible pairings of airlines on this route is $3*(3-2)/2=3$. Therefore, the average market contact for this route would be $90/3=30$.

industries. It is generally regarded that firms in a similar market position would find it easier to arrive at an agreement that suits all of them. Substantial asymmetry may imply a divergence of views between firms and make successful collusion more difficult (MacGregor 1906).

Green and Porter's (1984) imperfect monitoring model is not relevant to China's airline industry, as all the carriers use the same type of reservation system and the booking information is almost transparent to each of them. Also, some airlines that wish to enforce their price agreements even exchange details on a flight's revenue immediately after the departure of the flight.⁸

One may argue that as they are state-owned companies, some Chinese airlines might receive different forms of subsidies and thus they are in an advantaged position to compete. Asymmetry might arise from such subsidies. It cannot be denied that special subsidies to one airline could intensify price competition. However, following deregulation in the airline industry, the direct subsidies have been lessened. As far as we know, no airline today receives significantly different treatment from the government.⁹ Asymmetry arising from subsidies can be excluded from our consideration.

The main asymmetries come from the product differentiation caused by the reputation gained from having a safe record, frequent flyer programs, network size, etc. These factors may give advantages to some airlines as they lock consumers in. The disadvantaged airlines therefore may not be able to achieve their expected revenues at the agreed prices, and may find themselves better off by deviating from any collusive prices and selling at lower prices. This has actually been the case in China's airline markets, where many price agreements broke down immediately after they were formed.

We specify airline dummies to indicate whether an airline was serving a particular route in a given month. It is expected that the airline dummies can capture most of the asymmetries in terms of reputation, network size, frequent flyer programs, etc. For China Eastern, in terms of its involvement in price wars and price agreements, the most relevant rival airlines are Air China, China Southern, Shanghai Airlines and Hainan Airlines. These airlines have a heavy presence in China Eastern's sample markets. For China Southern, the most relevant rivals are China Eastern, Shanghai Airlines, Air China, Shenzhen Airlines and Hainan Airlines, and hence their presence is included in the models.

⁸ Our conversations with some of the airline sales managers in Shanghai show that this is one of the enforcement mechanisms employed to prevent cheating.

⁹ The government has helped the airlines through difficult times, however. For example, during the SARS period, all airlines were exempted from some taxes.

Demand Variable—Number of Passengers Carried

The review of the cartel and price war theories earlier in this paper reveals one theory that suggests collusion is more likely to break down in response to a business-cycle downturn in a contracting economy (Green and Porter 1984; Staiger and Wolak 1992; Slade 1992). Therefore, price wars are more likely to happen in periods of low demand. An opposing theory, which argues that price wars could happen in an expanding economy owing to the lure of high benefits from cheating compared with the possible costs of punishment, supports a countercyclical pricing pattern (Rotemberg and Saloner 1986). Suslow (2005) investigated the stability of cartels by looking at 71 international cartel agreements covering 45 industries during the period 1920–39 in Europe when cartel agreements were legal (these European countries did not have antitrust legislation before World War II), and found that a cartel is more likely fall apart during economic downturns and in the presence of economic volatility. It seems that frequent macroeconomic fluctuations increase the possibility of the collapse of a cartel (Carlton and Perloff 2005).

The demand variable included in our model is the number of passengers carried by China Eastern (China Southern) in a particular market for a given month. An endogeneity problem arises with this variable due to the fact that in a price war, the number of passengers carried by each airline is likely to increase, while a higher collusive price would make the air travel less attractive. To circumvent the endogeneity problem, population, disposable income and the number of carriers were used as instruments, following the approaches of Dresner and Tretheway (1992), Fischer and Kamerschen (2003), and Busse (2002). The population and the GDP per capita of China's cities come from China City Statistics Yearbook (2004). The geometric means of the populations and of GDP per capita for both route endpoint cities are used. The number of carriers can be obtained from the airline timetables.

Busy Airport Dummy

A dummy variable is specified for the airports that handled more than 10 million passengers in 2004 from which the flights depart (source: *China Civil Aviation Statistics* 2005). Airports in Beijing, Shanghai, Guangzhou, Shenzhen and Chengdu meet this criterion. These airports are usually congested in terms of take-off and landing slots and the use of airport facilities, and therefore a fare premium may arise but not necessarily imply market power per se (Levine 1987; Tretheway and Kincaid 2005). Price wars have also been found to be less likely to occur in the markets associated with these busy airports (Morrison and Winston 1996). It is expected that unilateral effects would seem to be less likely at these airports and coordinated effects would appear to be more possible.

Hub-to-Hub Market Dummy

Hub-to-hub markets are those where an airline has control over some of the airport facilities at both terminal airports of a particular route. More specifically, the two airports are the airline's primary, or one of its secondary, hubs. For example, after the mergers, China Eastern Group's primary and secondary hubs included: Shanghai, Jinan, Nanchang, Taiyuan, Hefei, Ningbo, Lanzhou, Nanjing, Wuhan, Xi'an and Kunming (source: China Eastern's website, available at www.ce-air.com). The China Southern group owns the following primary and secondary hubs: Guangzhou, Urumqi, Shenyang, Harbin, Changchun, Dalian, Shenzhen, Haikou, Zhengzhou, Wuhan, Changsha, Nanning, Zhuhai, Xiamen, Shantou and Guiyang (source: China Southern's website, available at www.cs-air.com). A market linking an airline's primary or secondary hubs is defined as a hub-to-hub market. A dummy with value 1 indicates such a market, and takes the value 0 otherwise. It is expected that an airline operating in its hub-to-hub markets has the abilities to lead both collusion and price wars.

Tourist route, month, Year, SARS variables

Traditionally, Guilin, Haikou, Sanya, Zhangjiajie, Huangshan, Hangzhou and Wuyishan are regarded as typical tourist cites whose economic growth is heavily dependent on the tourism industry. A vacation dummy was introduced in our price war and collusion models to allow for the effects of tourist markets. Year dummies and month dummies are included in our models. June is used as the benchmark category as our interviews suggested that it is usually regarded as a shoulder season. The Severe Acute Respiratory Syndrome (SARS) pandemic broke out in 2003 and affected the airline industry significantly, especially during its peak period in May-June 2003. To control for this unusual period, a SARS dummy is included.

A summary of the dependent and independent variables and their descriptive statistics is provided in Tables 1 and 2.

4. Results and Analysis

It should be noted that price wars and collusion in China's airline markets largely occurred on a route-by-route basis. There has not been a case where a price war or collusive price rise occurred simultaneously between the two carriers in all the markets they served. This is because pricing decisions were decentralised to the station managers or even the marketing staff at an airport who could closely monitor and respond promptly to rival airlines' prices. Therefore, once an airline significantly cuts the price on a particular route, almost all the airlines that operate on that route will match the price and get involved. Zhang and Round (2009a) have reported that almost identical prices were charged by China Eastern and China Southern on the same routes during 2002-2004.

Based on the definition of price wars and price collusion discussed earlier, the average fall when China Eastern participated in a price war, and the average increase when it

engaged in a price-fixing collusion, was 26% and 31%, respectively, and 28 % and 35 %, respectively, when China Southern did so. Figures 2 and 3 show that neither price wars nor price collusion lasted long. Typically 74% and 86% of the collusions in which China Eastern and China Southern participated, respectively, broke down within one month, while 59% and 69% of the price wars that the two airlines were involved in also ended within one month. The average duration of a price war was 1.7 months for China Eastern and 1.5 for China Southern. This is very different from the findings of Morrison and Winston (1996), who claimed that nearly 90% of the fare wars lasted two or fewer quarters with an average duration of 1.8 quarters. The price collusions in our study seem to be shorter lived than price wars, with an average of 1.5 months for China Eastern and 1.4 for China Southern. However, it can also be seen in the figures that there was a small number of instances where collusion lasted for more than two months. Longer duration is an indicator of successful collusion.

In a country where antitrust laws make explicit pricing agreements illegal and collusion can only be achieved implicitly through repeated interactions, firms might use the lessons they learned from past experience and act cautiously in upsetting an implicit collusion, as they do not know whether they can quickly establish another one. However, given that the price agreements in China were not totally illegal and could be achieved in many ways, a price agreement could be established quickly any time the airlines wished. If one of the members was not happy with the outcome of an agreement, collusion could quickly break down because of the lack of an effective enforcement mechanism, but it was easy enough to form another one soon thereafter. This might explain why price wars and price collusion in China have tended to be short-lived.

The natural questions are how a price war started and how it ended in China's airline markets. Without resorting to in-depth interviews with the relevant parties, the true causes may never be established by merely relying on statistical data. In fact, as the services provided by different airlines are not perfectly substitutable, there will always be a relatively disadvantaged airline that has lower revenue on a route than that of other members of the collusive group. In most instances, the only choice for a disadvantaged airline to increase its total revenue is to cut prices (owing to the elastic demand at the agreed price level). When all the airlines follow suit, a price war will break out.

The base airline (with headquarters in the city) usually plays an important role in coordinating an agreement to end the war on the route out of that city. Our interviewees all expressed the view that the base airline should take the responsibility to call all the relevant parties in for talks. If this did not work, the station managers would report the case to their own top management for action, and communication at senior levels could then terminate a war. This suggests that, quite often, the end of a war implies the formation of a collusive agreement. In this sense, price wars could be interpreted as a means to enforce collusive agreements, sometimes leading to a more stable agreement after lessons had been learned.

One strategy used by the airlines to keep a collusive agreement alive, according to our interviews, is to design a plan to accommodate the disadvantaged carrier on a route. For example, the main carriers could allow the disadvantaged airline to sell at a lower price level, say 10 % lower, while others stick to the agreed price, so that all airlines can have roughly equal revenue in a particular market proportional to the number of seats that each carrier offers. Our data indicate that there was a slight increase in the duration of collusive agreements in 2004. Our interviews suggested that in 2005 on a small number of routes, the agreements using such approach were quite successful. However, given that any collusive contract could not cover all the aspects of the participants' interests and that the outside conditions on a particular route changed from time to time, it was the norm for agreements to collapse frequently, followed by a new one formed soon after the price wars, with new additional conditions to suit each individual airline's needs.

The different goals of airlines on a particular route could also be one of the causes of price wars and explain the irrational behaviour observed during these wars. The big three airlines had much less trouble than the local airlines in making profits due to their widespread networks which made cross-subsidising possible. Our interviewees emphasised that once price wars broke out, the large airlines could be more irrational if the markets concerned were not their main profit earners, but they were the main sources of revenue for the local airlines. On these routes, the major airlines' goals could be quite different from those of the local airlines. They may simply want to enhance or maintain their market shares, and so the large airlines could start a war on these routes and set the price at unexpectedly low levels.

For most cases, price wars were begun by an airline with a relatively small market share and a poor load factor. For airlines that dominated the routes, they most likely responded by cutting their prices, but these prices could remain at least 5% higher than those of the low market share carriers, as they would know that their larger frequencies could offer more flexibility and so they would retain the patronage of most of their passengers. Repeated wars of this kind have led to the larger airlines agreeing to the small market share carriers charging slightly lower prices when negotiating new agreements, as discussed earlier.

The difficulties in enforcing collusive airline agreements are considerable, given the need to cater for different groups of passengers. For example, the cheaters could disguise their price cuts in the name of discounts offered to tourist groups. Thus, a booking for a group appears to be for a return tourist trip, but the cheating airline may cancel their return flight after the outbound flight departs. These passengers are in fact not tourists but have been given tour group prices. However, such behaviour could be revealed in some way to rival airlines by the travel agent or the passengers, and a price war would soon follow. Given the lack of effective punishments to impose on cheaters, apart from price wars, our interviewees claim that the negotiation and coordination abilities of the sales managers are the key to preventing wars and maintaining the price agreements for a long time.

Given the somewhat arbitrary nature of our definition of price wars and collusion, we then tried alternative definitions of price wars and collusion. The duration of the two pricing behaviours are reported in Figures 4 and 5. Awar1 represents the beginning of a price war when the price has decreased by 15% from the previous month and an end of the war when the monthly average price has gone up by 10% from the previous month (or when the accumulated increases reach 10% in the previous consecutive months¹⁰). Awar2 alternatively defines a price war with the necessary decrease being measured as 25% and the increase being 10%. Similarly, we have two definitions for collusion corresponding to Awar1 and Awar2 respectively.

Our conclusion does not change significantly with the alternative definitions as shown in Figures 4 and 5, as the majority of the price wars and collusive conduct episodes still tend to last only one or two months, especially in China Southern's markets.

Figures 6 and 7 present the number of price wars and the number of instances of collusion that were present in China Eastern's sample markets from January 2002 through to December 2004. Figure 6 is based on the base definition of price wars and collusion that we discussed in section three, i.e., a 20% decrease (increase) at the beginning and a 5% increase (decrease) at the end. The discontinuity in August 2002 is due to missing data for China Eastern on all its routes. Figure 7 comes from the alternative definitions just discussed. Both price wars and collusion appear to have occurred more frequently after the airline mergers in October 2002 in China Eastern's markets. Generally similar patterns can be found in Figures 8 and 9 for China Southern. Although we find that price wars and price collusion coexisted for most of the periods, generally, when the frequency of price wars was high, the number of collusive episodes in the sample markets was low, suggesting seasonal demand changes could be an important factor eliciting the collapse of a collusive agreement.

The results of the price war and collusion models for China Eastern are reported in Table 3 and those for China Southern are given in Table 4.¹¹ The interpretation of probit coefficients is not analogous to the corresponding coefficients obtained by linear regression models. The magnitude of each coefficient is not especially useful in a practical sense. Therefore, the marginal effect (or partial effect), which shows the effect of an infinitesimal change in a continuous independent variable on the probability of a price war or collusion, is usually reported. In the case of a non-continuous variable, such as a dummy variable, the marginal effect reports the discrete change in the probability of this dummy variable changing from 0 to 1. The

¹⁰ In some cases, the price increases by 3%, 4%, and 5% in three consecutive months rather than by 10% in one month. In these cases, we consider the price war ends in the third month.

¹¹ Only the results using the base definition of price wars and collusion are reported, as we believe that, based on the work experience of one of the authors in the Chinese airline industry, the base definition is more representative of the actual facts. The models were estimated using Stata command "ivprobit" with a maximum likelihood estimation method.

marginal effects of the significant variables provided in the two tables were computed at the means of the independent variables.¹² For each model, the Wald test statistic shows that the hypothesis that all the coefficients are simultaneously zero can be rejected at the 1% significance level.¹³

In our data sets, the number of passengers variable reflects demand fluctuations both across routes and over time. This may not correspond to the theoretical models of price wars in Green and Porter (1984) and Rotemberg and Saloner (1986), whose models seem to pertain only to demand fluctuations over time. Although not entirely comparable, the negative sign in the price-war model for China Southern gives some support to the view of Green and Porter that a price war is more likely to erupt when demand is low.¹⁴ Also, the collusion model (China Southern) shows that successful collusion is less likely to be maintained in a market where demand is high. This seems to be consistent with the conclusion in Rotemberg and Saloner (1986) that collusion is hard to maintain in booms. The results of the passenger variable suggest that both price wars and price collusion could happen in a low demand period or in a market where air travel demand is relatively low. It could also be the case that when demand was low, some routes were experiencing price wars, while some others were engaging in price-fixing activities.

The seasonal effects as well as the effect of the SARS dummy provide further evidence that demand fluctuations have an impact on the airlines' pricing behaviour. Compared with the shoulder season in June, peak seasons such as January (before the Chinese New Year) and April (before the week-long holiday for Labour Day) in all the models show that an inference can be made about a strong tendency towards collusion and less likelihood of a price war. Our interviews suggest that the airlines are well aware of the times of peak and low seasons. The incentive to coordinate pricing during high seasons is stronger as they believe that the profits in this period can cover the losses in the low seasons. Therefore, it was common practice for the sales managers to meet before the advent of the peak season to form an agreement, as they understood that if they lost peak time revenues, they would suffer losses for the whole year. Therefore, most of airlines observed the agreements quite closely when

¹² For example, in China Eastern's price-war model, the tourism routes have a 4% higher probability of experiencing a price war (at the means of the independent variables).

¹³ To avoid the coefficient being too small in magnitude, we rescaled the *oapthhi*, *distance* and *paxn* variables by dividing them by 100. The rescaling will not affect the interpretation of the results (Wooldridge 2006).

¹⁴ A similar conclusion in support of Green and Porter (1984) was arrived at by Brander and Zhang (1993) who included a macroeconomic variable (real GNP) in their regression and found that it had a significant positive effect on the collusive conduct of United Airlines.

demand was high, even though this sometimes meant that the flights were not full.¹⁵ This again supports the view of Green and Porter (1984). However, coefficients on the SARS dummy suggest that when air travel demand was extremely low, the probability of collusion significantly increased for both China Eastern and China Southern. As a result, the likelihood of price wars occurring was reduced. This seems to be consistent with the rationale presented in Rotemberg and Saloner (1986).

Another week-long holiday (1-7 October) does not appear to induce more collusive activities, but the two price-war models show that the chance of getting into a war is diminished in October as well as September for China Southern. For China Eastern, more price wars could be seen in November, which confirms our interview information. For China Southern, as well as January, April, September and October, price wars are also less likely in December. This can be explained by the vicinity of its headquarters (Guangzhou) to Hong Kong where Christmas is the public holiday.

The year dummies reveal that compared with 2002, both China Eastern and China Southern tended to participate in more collusive agreements in 2003 and 2004 (but not significantly for the 2003 dummy in China Eastern's collusion model), after the airline mergers. This has already been observed in Figures 6-9. Only China Eastern appears to engage in more price wars in 2003 at the 5% significance level. If we could assume that most of the collusive agreements would last for a long time, then most likely we would have seen price increases in 2003 and 2004. However, a previous study (Zhang and Round 2009a) has shown that on average, 2003 and 2004 experienced substantial drops in airfares on most routes compared with 2002.

The contradictory results suggest that although the reduction in the number of competitors following the mergers would have facilitated the negotiation of price agreements, most were not effectively enforced and quickly died out. Not surprisingly, the declining trend in airfares was not changed by any more frequent engagement in collusion.

It is understandable that Air China, with its business mainly centered on international routes, tended to be reluctant to engage in fare wars in its domestic markets. Shanghai Airlines, a strong competitor on many routes out of Shanghai, which shares the same base airport with China Eastern, might be very familiar with China Eastern's operations and thus mutual forbearance and convenient communication might have helped them avoid destructive competition. The presence of China Eastern on China Southern's routes increased the likelihood of both price wars and price collusion at the

¹⁵ A recent collusion episode also happened in April 2009 when all the airlines announced the use of a new airfare calculation formula from 20 April 2009, which led to various increases in prices for all the carriers in the domestic markets. This obvious price-fixing activity has drawn the attention of the newly established antitrust authority under the new Anti-Monopoly Law.

10% and 5% significance levels respectively, indicating that these two airlines, of similar size, fought against one another fiercely in one period and cooperated in harmony in another period, or competed on some routes and colluded on others. Table 3 also shows that the presence of China Southern in China Eastern's markets could intensify competition between the two carriers.

The presence of Hainan Airlines did not induce more price wars in China Eastern's sample markets. However, its presence could increase the likelihood for China Southern to engage in price wars. This finding is not surprising as Zhang and Round (2009b) found that Hainan Airlines has had the effect of disciplining the major airlines in pricing, especially for China Southern, as the primary bases of the two airlines are geographically quite close. Departures from one of the top 5 busiest airports would be more likely to see a price war in China Eastern's sample markets, but the presence of a busy airport did not have any serious impact on airline cooperation. However, this is not to say that collusion did not happen in the markets departing from these cities. It is possible that that markets associated with these cities are crucial to the airlines involved in terms of generating large amounts of revenue, and therefore it is in every player's interest to keep airfares in these markets as high and stable as possible through collusion. Without dramatic changes in prices, our measurement of collusion cannot capture such types of price cooperation.

The tourism markets of both China Eastern and China Southern experienced more price wars, reflecting higher elasticities of travellers' demands on this type of route. The tourism routes had little effect on the likelihood of forming a price union, as disclosed by the price collusion models of the two airlines.

In China Southern's hub-to-hub markets, price wars seemed to be less likely to occur. China Southern's price-war model shows that longer routes were more likely to experience price wars. One possible reason could be that relatively low personal disposable income in many areas of China constrains the use of air transport for long-distance travel (in fact, for the vast majority of the population, travel by train is the first choice, especially when long-distance travel is very expensive). An additional possible reason is that longer routes are usually associated with a route involving a rival's hub airport, and thus competition tends to be strong. In contrast, shorter routes are usually within an airline's sphere of influence and a certain degree of market power could be exercised. The sign of the distance variable is also positive in China Eastern's price-war model, but it is not statistically significant. For collusion models, the distance variable did not have a significant effect.

We move now to the concentration measures. For China Eastern, an increase in departure airport HHI, on the one hand, increased the likelihood of price wars (at the 10% significance level). On the other hand, it also increased the likelihood of a successful price agreement (at the 1% significance level). These findings once again are not conflicting. Rather, it is very likely that when there is a price war, price collusion follows in the same market. The market share at the departure airport seems

to have no significant impact on the price wars and collusion. Although economic theory suggests that collusion is more likely to occur in concentrated markets, we have not generally found this result in all the models we have estimated. This is consistent with the survey conducted by Levenstein and Suslow (2006) who conclude that there is no simple relationship between industry concentration and the likelihood of collusion. However, we cannot exclude the possibility that firms in China's concentrated airline markets had the ability to alleviate price fluctuations, or to collude with a moderate pricing strategy, and perhaps on other competitive variables such as flight schedules and capacity that cannot be captured by our price-war and collusion models.

Finally, any increase in multimarket contact had no significant effect for China Eastern in terms of its engagement in either price wars or collusion. This variable, however, indicates that China Southern was more likely to get involved in a price war at the 5% significance level. This contradicts the traditional mutual forbearance hypothesis, but is consistent with the findings of Morrison and Winston (1996). They give the explanation that although multimarket contact might facilitate carrier cooperation that reduces the chance of price wars, it can also facilitate the spread of price wars once the cooperation breaks down. This might also be true in China's airline market. As well, owing to the strong rivalry in China's airline markets, explicit price-fixing agreements generally could not be expected to last long, let alone any implicit collusion implied by mutual forbearance. In addition, airline pricing decisions are generally made locally. A successful and stable collusion is largely dependent on the negotiation skills of the local sales managers as noted earlier, and these will reflect each individual's self-interest. Under these circumstances, mutual forbearance or implicit collusion across the board is quite difficult to achieve.

5. Conclusion

Identifying and generalizing the factors that sustain successful collusion continues to be a difficult, but important research topic, especially in emerging markets such as China, where the new antitrust authorities urgently need rigorous analysis of this phenomenon to have a better understanding of the mechanisms of collusion in different contexts. To the best of our knowledge, this paper is the first academic paper that documents price wars and collusion in China's airline markets, which many Chinese consumers have experienced and observed. By using monthly fare data to study the period from 2002 to 2004, during which airline consolidations eliminated many trunk and local airlines, it has been found that the occurrence of price wars was not tempered by the mergers. Fare wars occurred periodically across routes, but price collusion was still prevalent.¹⁶ However, both tended to be short-lived. Our interview

¹⁶ Note that we say it is "prevalent" because, compared with other airline markets, price collusion in China's markets has been frequently observed. It does not literally mean that collusive conduct occurs simultaneously in most of the airline markets.

information obtained from airline staff reveals the importance of changes in demand in inducing or promoting collusion in China. Although it is almost certain that airlines tended to engage in collusion when demand was high, there is also evidence from our price-war and collusion models which suggests that collusion could happen during low demand periods.

It should be pointed out that most of our explanatory variables did not have consistently significant effects on the occurrence of price wars or price collusion engaged in by both China Eastern and China Southern. For example, high airport concentration measured by HHI may facilitate collusion in certain circumstances, but it may also lead to more price wars under other conditions. The rejection of the existence of mutual forbearance owing to multimarket contact demonstrates that in dealing with airline merger cases, at least in China, there seems to be no major need to attach too much attention to the potential anticompetitive impacts of this variable, in contrast to previous claims made by many economists. It is, therefore, hard to generalise a set of factors that facilitate price wars or collusion as people might like to see. This reflects the nature of oligopolistic interdependence where any outcome could be possible, as reflected by numerous theoretical game models using different assumptions about firm behaviour and responses to rivals' strategies. Therefore, it is recommended that caution is needed in approving or rejecting proposed mergers, at least in China's airline industry, especially if using a "checklist" of the factors (for example, the factors listed in the Australian Merger Guidelines¹⁷) thought to be necessary to consider assessing the anticompetitive effects of a proposed merger.

The short-lived collusive agreements reported in our paper might represent different policy challenges compared with those needed to deal with the relatively long-lived cartels identified by Porter (1983), as well as other international cartels surveyed in Levenstein and Suslow (2006). However, our study also shows that a small number of markets had consistently higher prices for a relatively long time. Stable collusion may exist in a few markets that are vital to profits of the relevant airlines. More dangerously, if the skills of cooperative negotiations improve, and if efficient enforcement mechanisms can be developed, price agreements could become long-lived. China thus needs an operationally-effective modern antitrust law in order to develop a culture for competition, and to ban any implicit and explicit collusion between rival firms throughout the economy.

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¹⁷ See www.accc.gov.au

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Table 1 Descriptive statistics for China Eastern's data

Variable	Description	Obs	Mean	Std. Dev.	Min	Max
War	War = 1 if China Eastern is experiencing a price war	3266	0.051	0.219	0	1
Collusion	collusion = 1 if China Eastern is participating in collusion	3266	0.081	0.273	0	1
oaptshare	market share for China Eastern at departure airport	4068	0.244	0.145	0	0.829
oapthhi	Herfindahl–Hirschman index of departure airport	4068	2723.715	1148.535	1261.177	7844.215
murouteshare	share of China Eastern in a route market	4068	0.406	0.252	0	1
mnc	average route market contact	4068	36.517	24.779	0	115
distance	route distance	4068	1180.593	577.040	160	3649
tourismroute	tourismroute = 1 if a market is a tourism market	4068	0.212	0.409	0	1
busyapt	busiapt = 1 if the departure airport is one of the 10 busiest airports	4068	0.531	0.499	0	1
hubtohub	hubtohub = 1 if a market links China Eastern's primary or secondary hubs	4068	0.124	0.330	0	1
sarsdummy	Sarsdummy = 1 for periods of May and June 2003	4068	0.056	0.229	0	1
ca	ca = 1 if Air China is present in a market	4068	0.204	0.403	0	1
cz	cz = 1 if China Southern is present in a market	4068	0.290	0.454	0	1
fm	fm = 1 if Shanghai Airlines is present in a market	4068	0.260	0.439	0	1
hu	hu = 1 if Hainan Airlines is present in a market	4068	0.171	0.377	0	1
y2003	y2003 = 1 for year 2003	4068	0.333	0.471	0	1
y2004	y2004 = 1 for year 2004	4068	0.333	0.471	0	1
Jan, Feb, Mar, Apr, May, Jul, Aug, Sep, Oct, Nov, Dec	Each month dummy takes 1 in that particular month otherwise 0.	4068	0.083	0.276	0	1
paxno	the number of passengers carried by China Eastern in a market in a given month	3661	6020.447	7371.054	26	71645

Table 2 Descriptive statistics for China Southern's data

Variable	Description	Obs	Mean	Std.Dev.	Min	Max
War	War = 1 if China Southern is experiencing a war	2451	0.057	0.232	0	1
Collusion	collusion = 1 if China Southern is participating in collusion	2450	0.091	0.288	0	1
oaptshare	market share for China Southern at departure airport	2736	0.355	0.182	0.021212	0.879227
oapthi	Herfindahl–Hirschman index of departure airport	2736	2902.162	909.064	1261.177	7844.215
czrouteshare	share of China Southern in a route market	2736	0.581	0.273	0	1
mnc	average route market contact	2736	41.154	31.549	0	115
distance	route distance	2736	1214.237	650.549	452	3836
tourismroute	tourismroute = 1 if a market is a tourism market	2736	0.263	0.440	0	1
busyapt	busyapt = 1 if the departure airport handled 10, 000,000 passengers in 2004	2736	0.552	0.497	0	1
hubtohub	hubtohub = 1 if a market links China Eastern's primary or secondary hubs	2736	0.211	0.408	0	1
sarsdummy	Sarsdummy = 1 for periods of May and June 2003	2736	0.056	0.229	0	1
ca	ca = 1 if Air China is present in a market	2736	0.188	0.391	0	1
mu	mu = 1 if China Eastern is present in a market	2736	0.498	0.500	0	1
fm	fm = 1 if Shanghai Airlines is present in a market	2736	0.271	0.444	0	1
zh	zh = 1 if Shenzhen Airlines is present in a market	2736	0.033	0.178	0	1
hu	hu = 1 if Hainan Airlines is present in a market	2736	0.206	0.405	0	1
y2003	y2003 = 1 for year 2003	2736	0.333	0.471	0	1
y2004	y2004 = 1 for year 2004	2736	0.333	0.471	0	1
Jan, Feb, Mar, Apr, May, Jul, Aug, Sep, Oct, Nov, Dec	Each month dummy takes 1 in that particular month otherwise 0.	2736	0.083	0.276	0	1
paxno	the number of passengers carried by China Southern in a market in a given month	2576	7408.702	7657.076	145	48744

Table 3 Price war and successful collusion determinants for China Eastern

	Coef.	Std. Error	Marginal Effect (dy/dx)		Coef.	Std. Error	Marginal Effect (dy/dx)
Dependent variable: war				Dependent variable: collusion			
oaptshare	0.216	0.369		oaptshare	0.096	0.328	
oapthhi	0.008*	0.004	0.001	oapthhi	0.014***	0.004	0.002
murouteshare	-0.427*	0.228		murouteshare	-0.205	0.213	
mnc	-0.001	0.002		mnc	-0.001	0.002	
distance	0.011	0.008		distance	0.001	0.007	
tourismroute	0.408***	0.095	0.040	tourismroute	-0.144	0.092	
busyapt	0.352***	0.120	0.027	busyapt	0.059	0.109	
hubtohub	0.189	0.142		hubtohub	-0.224*	0.131	-0.024
sarsdummy	-0.043	0.244		sarsdummy	0.847***	0.167	0.171
ca	-0.300**	0.118	-0.020	ca	-0.042	0.095	
cz	0.212**	0.108	0.018	cz	0.155	0.096	
fm	-0.276**	0.129	-0.019	fm	0.131	0.118	
hu	0.076	0.106		hu	0.149	0.096	
y2003	0.273**	0.116	0.023	y2003	0.054	0.129	
y2004	-0.024	0.120		y2004	0.444***	0.116	0.057
Jan	-0.525*	0.288	-0.027	Jan	0.494***	0.163	0.085
Feb	0.069	0.206		Feb	-0.283	0.182	
Mar	0.270	0.198		Mar	-0.273	0.180	
Apr	-0.232	0.224		Apr	0.439***	0.152	0.072
May	-0.367**	0.231	-0.026	May	0.148	0.139	
Jul	0.277	0.202		Jul	-0.271	0.182	
Aug	-0.026	0.234		Aug	-0.139	0.186	
Sep	-0.157	0.249		Sep	-0.290	0.195	
Oct	-0.508**	0.240	-0.027	Oct	-0.130	0.170	
Nov	0.389**	0.195	0.040	Nov	-0.636***	0.211	-0.050
Dec	0.227	0.200		Dec	-0.230	0.176	
paxno	-0.002	0.001		paxno	0.000	0.001	0.000
_cons	-2.159	0.262		_cons	-2.081	0.222	
Summary statistics:				Summary statistics:			
1.Number of observations = 3263				1.Number of observations = 3263			
2. Log likelihood = -18249.96				2. Log likelihood = -18464.55			
3. Wald test of overall significance: chi-square(27) = 104.16***				3.Wald test of overall significance: chi-square(27) = 198.08***			

*Significant at 10%;**significant at 5%; ***significant at 1%.

Instruments: number of carriers, geometric means of populations and of GDPs per capita of route endpoints.

Table 4 Price wars and successful collusion determinants for China Southern

Dependent variable: war			Dependent variable: collusion				
Coef.	Std. Err.	Marginal Effect (dy/dx)	Coef.	Std. Err.	Marginal Effect (dy/dx)		
oaptshare	0.499	0.347	oaptshare	-0.128	0.293		
oapthhi	-0.005	0.006	oapthhi	-0.007	0.006		
czrouteshare	0.241	0.270	czrouteshare	-0.183	0.222		
mnc	0.006**	0.002	0.000	mnc	-0.003	0.002	
distance	0.027***	0.009	0.002	distance	0.000	0.007	
tourismroute	0.214**	0.104	0.018	tourismroute	0.003	0.097	
busyapt	-0.069	0.113		busyapt	-0.027	0.093	
hubtohub	-0.488***	0.162	-0.030	hubtohub	-0.142	0.112	
sarsdummy	-1.033***	0.310	-0.036	sarsdummy	0.664***	0.205	0.131
ca	0.250*	0.133	0.022	ca	0.057	0.119	
mu	0.288*	0.172	0.023	mu	0.348**	0.154	0.046
fm	-0.032	0.146		fm	-0.086	0.133	
zh	-0.084	0.134		zh	0.645***	0.235	0.127
hu	0.363***	0.134	0.034	hu	0.460***	0.120	0.075
y2003	0.157	0.134		y2003	0.390***	0.127	0.056
y2004	-0.127	0.128		y2004	0.581***	0.115	0.087
Jan	-0.988***	0.314	-0.037	Jan	0.651***	0.196	0.126
Feb	-0.144	0.202		Feb	0.344*	0.191	0.055
Mar	-0.191	0.207		Mar	-0.301	0.232	
Apr	0.670***	0.237	-0.032	Apr	0.816***	0.178	0.168
May	-0.130	0.208		May	0.240	0.173	
Jul	0.298*	0.216	-0.018	Jul	0.261	0.193	
Aug	-0.238	0.210		Aug	-0.327	0.235	
Sep	-0.486**	0.225	-0.026	Sep	-0.122	0.213	
Oct	-0.843***	0.265	-0.036	Oct	0.312	0.192	
Nov	-0.203	0.206		Nov	0.084	0.207	
Dec	-0.597**	0.230	-0.030	Dec	-0.310	0.236	
paxno	-0.004***	0.001	0.000	paxno	-0.005***	0.001	-0.001
_cons	-1.995***	0.315		_cons	-1.558***	0.272	

Summary statistics:

1. Number of observations = 2451
2. Log likelihood = -13437.81
3. Wald test of overall significance: chi-square(28) = 105.51***

Summary statistics:

1. Number of observations = 2450
2. Log likelihood = -13614.99
3. Wald test of overall significance: chi-square(28) = 179.58***

*Significant at 10%; **significant at 5%; ***significant at 1%.

Instruments: number of carriers, geometric means of populations and of GDPs per capita of route endpoints.

Figure 1 Price wars and collusion on route Guangzhou-Hefei

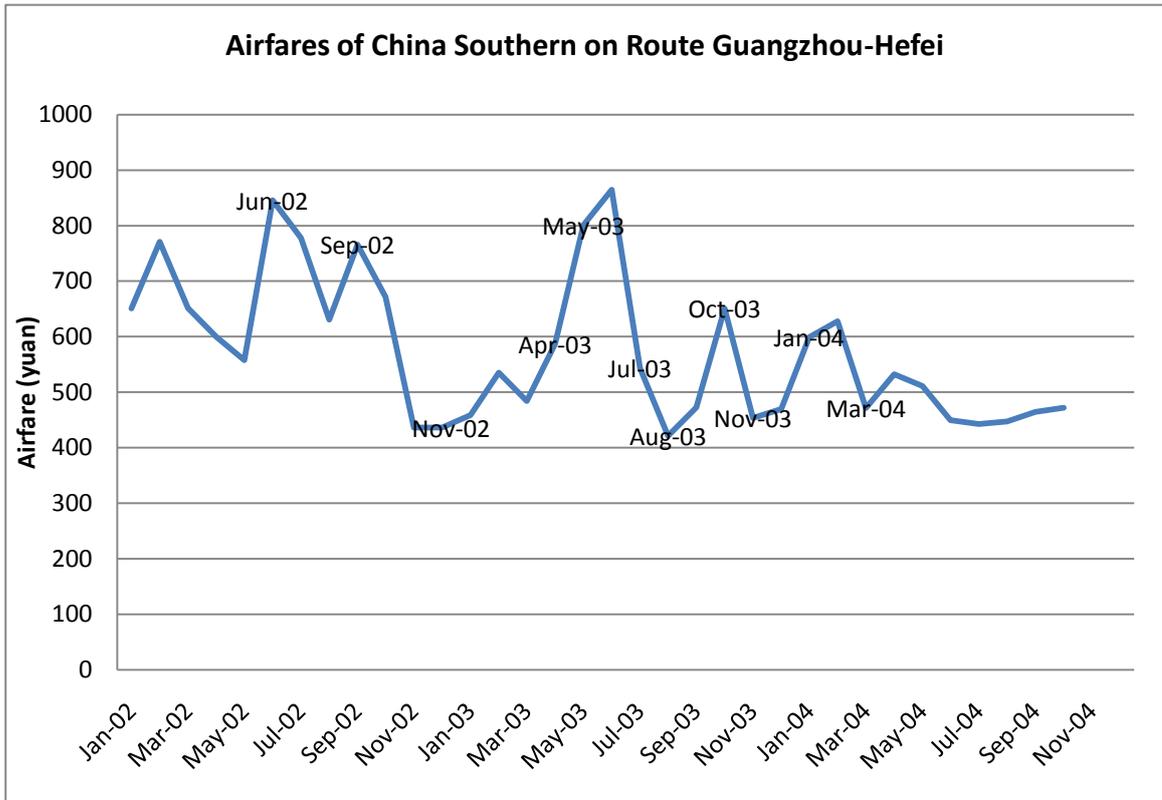


Figure 2 Distribution of duration of price wars and collusion in China Eastern's markets

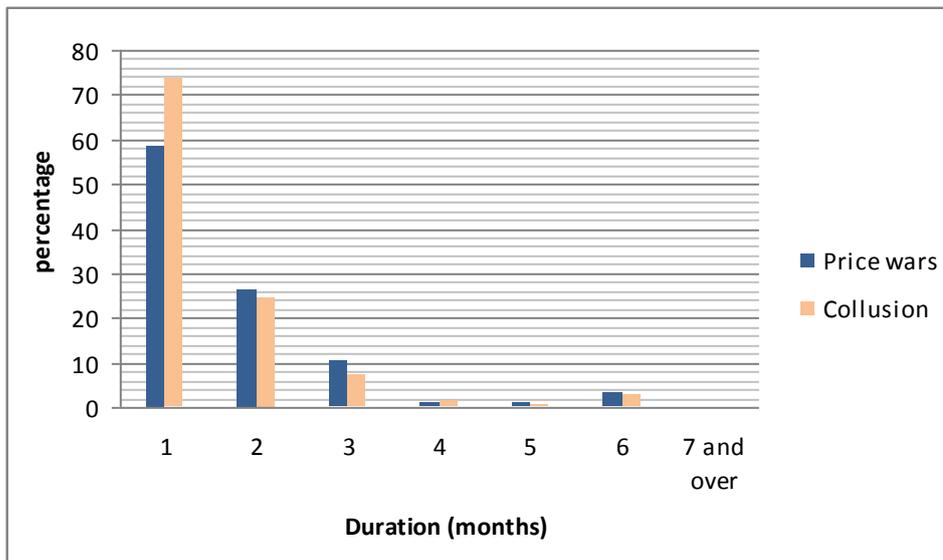


Figure 3 Distribution of duration of price wars and collusion in China Southern's markets

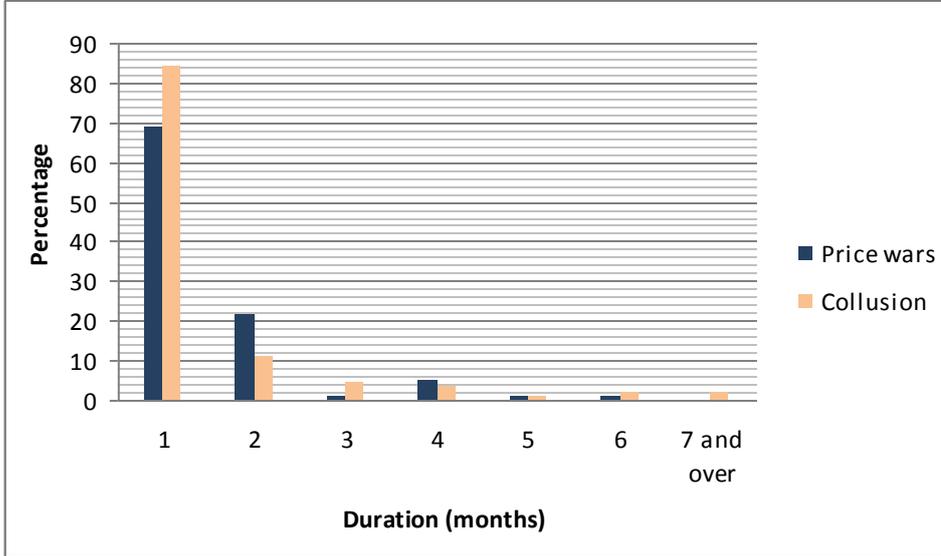


Figure 4 Distribution of duration of price wars and collusion (alternative definitions) in China Eastern's markets

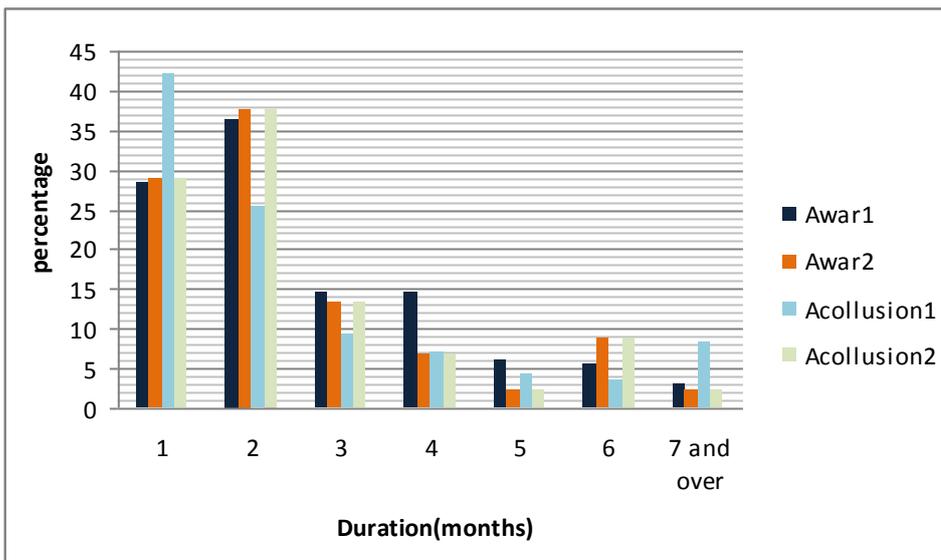


Figure 5 Distribution of duration of price wars and collusion (alternative definitions) in China Southern's markets

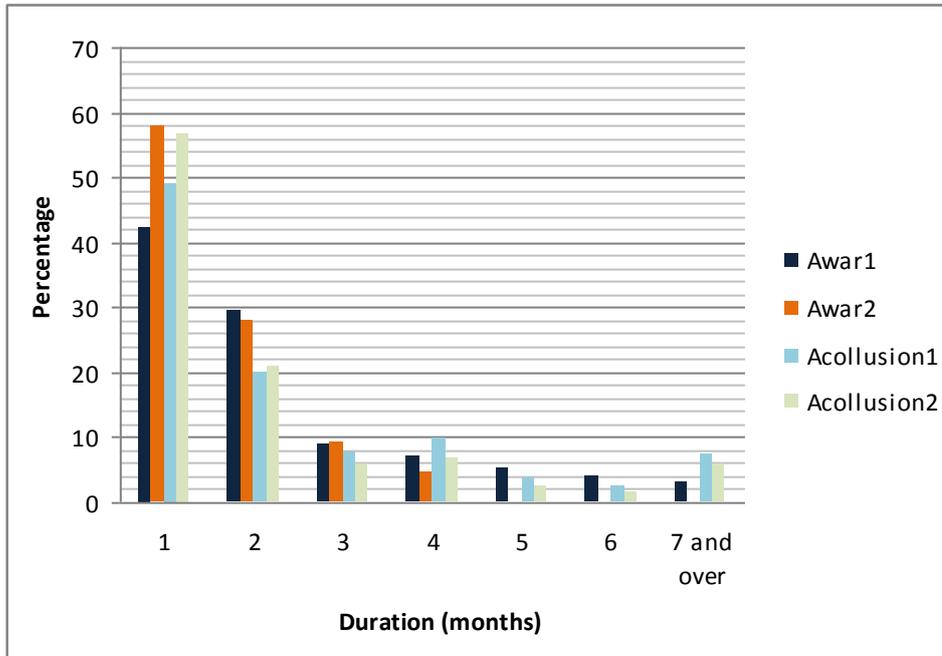


Figure 6 Number of price wars and collusive conduct episodes in China Eastern's markets (base definition)

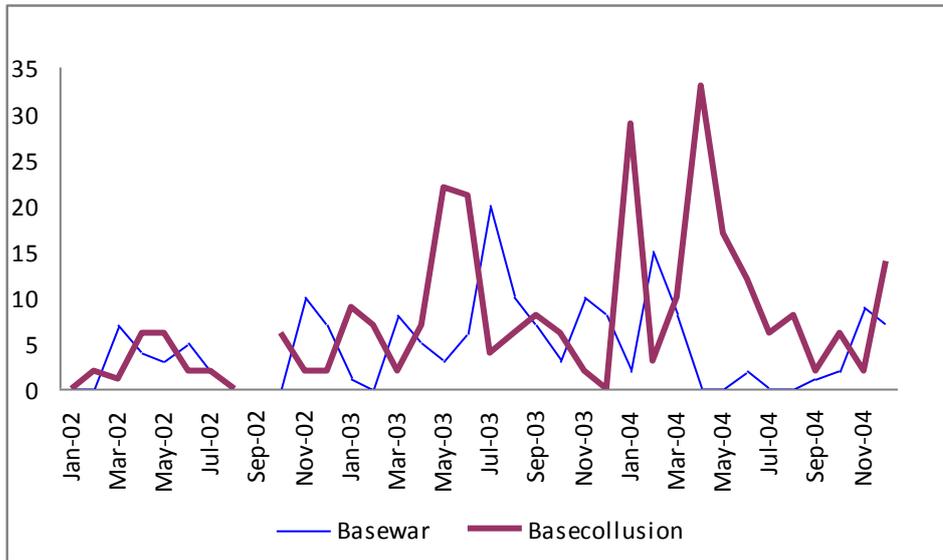


Figure 7 Number of price wars and collusive conduct episodes in China Eastern's markets (alternative definitions)

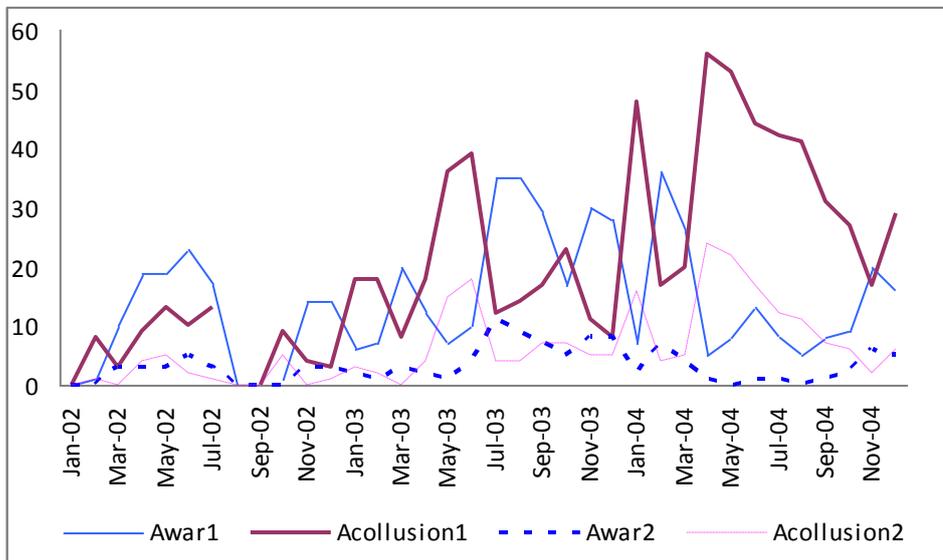


Figure 8 Number of price wars and collusive conduct episodes in China Southern's markets (base definition)

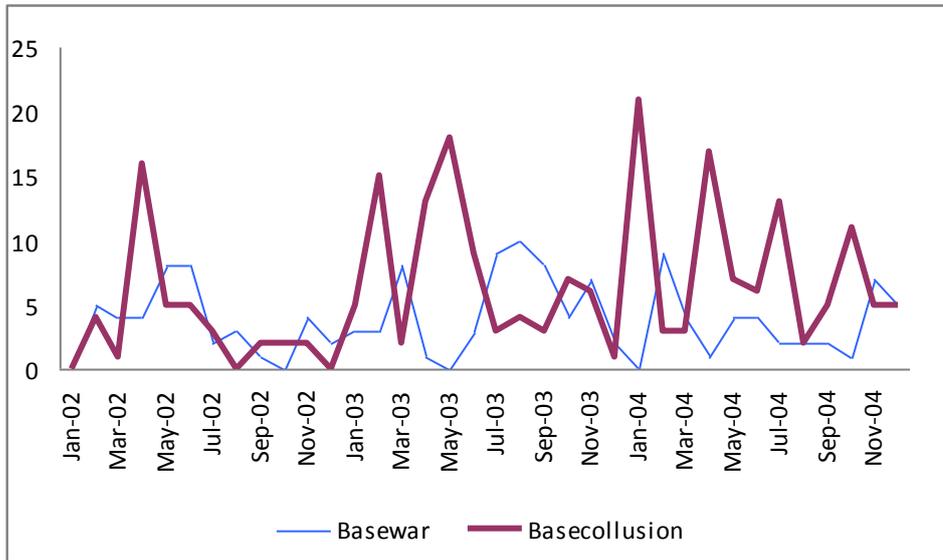


Figure 9 Number of price wars and collusive conduct episodes in China Southern's markets (alternative definition)

