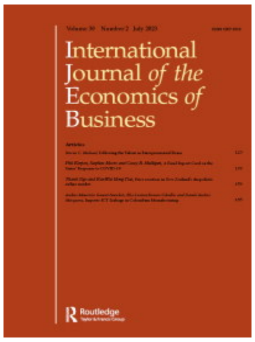

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ABSTRACT

This study investigates the price reaction in a duopolistic market where two airlines (a full-service and a low-cost carrier) dominate the domestic aviation market. Utilising a rich dataset of 53,463 matched airfares for Air New Zealand and Jetstar in New Zealand from September to December 2019, we found a U-shaped relationship (from Jetstar to Air New Zealand) and an inverted U-shaped relationship (from Air New Zealand to Jetstar) between the two airfares. While distinguishing their different business models, such behaviour has not been empirically discussed in the literature. This study can be extended to larger and more complex markets.

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1. Introduction

This study investigates the price reaction, i.e. prices matching and reacting to each other, in a naturally duopolistic domestic aviation market. Although a number of studies (Hazledine 2011a; Obermeyer, Evangelinos, and Püschel 2013; Zhang, Derudder, and Witlox 2013; Varella, Frazão, and Oliveira 2017) have investigated airfare competition and airline pricing behaviour, especially between low-cost carriers (LCCs) and full-service carriers (FSCs), those studies only focus on the price dispersion issue but not the price reaction/matching (Avogadro et al. 2021). With the help of the internet, airfares are now provided to travellers in a quick and convenient way (Ho et al. 2021). It, however, requires the airlines to adjust their fares more frequently to react to any changes in the airfares of their competitors. This behaviour would be more obvious in a duopolistic market where there are only two key players, an FSC and an LCC, who dominate the market, as in the case of New Zealand (Henderson et al. 2019).

New Zealand has enthusiastically embraced moves to liberalise aviation both domestically and internationally (Kissling 1998). The growth of LCCs since 2009 has been dramatic in New Zealand's domestic aviation market. LCC market shares increased from just 7.34% in 2009 to 16.60% of total scheduled domestic seats in 2019 (Official Airline Guide 2022). With the rapid growth of a LCC (Jetstar – the subsidiary of Qantas) serving

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New Zealand's domestic aviation market, the dominant flag carrier (Air New Zealand) had to fly to remain competitive and make changes to adapt to this new competitive environment (Gorin and Belobaba 2008). However, studies on New Zealand aviation market are still limited (Tsui, Gilbey, and Balli 2014; Tsui 2017; Henderson et al. 2019; Ngo and Tsui 2020), not to mention the airline competition and price reaction issues (Hazledine 2011b, 2011a; Gillen and Hazledine 2016).

This study makes two key contributions to the air transport literature. Firstly, to the best of our knowledge, this study is the first to empirically investigate the duopolistic price reaction between a dominant airline and its main LCC competitor in New Zealand's domestic aviation market (i.e. Air New Zealand *vs.* Jetstar). Although there are many studies in the air transport literature that have examined airline pricing behaviour among FSCs and/or LCCs, there is room for a study on New Zealand which is considered to be a liberalised aviation market (Kissling 1998) that has a naturally duopolistic characteristic (Henderson et al. 2019), especially considering price reaction/matching. Importantly, for the price reaction between the two airlines, we have found a U-shaped relationship (from Air New Zealand to Jetstar) and an inverted U-shaped relationship (from Jetstar to Air New Zealand), which distinguish their different business models (i.e. FSC *vs.* LCC) but has not been empirically discussed before in the aviation literature. Secondly, this study discusses issues of competition and dynamics in airline pricing competition that have policy relevance to New Zealand's domestic aviation market, considering that Jetstar withdrew some regional flight services from its regional route networks, as well as the transformation of structural competition in New Zealand's air travel market. This study attempts to answer the following research question:

- How is airline price reaction affected by New Zealand's duopolistic domestic aviation market and what are the airfare pricing determinants?

This study analyses a large dataset of airfares charged by Air New Zealand and Jetstar on all New Zealand's domestic routes (including trunk and secondary routes) for a pre-Covid-19 period from 16 September 2019 to 16 December 2019 (to avoid any impact of the pandemic on the airlines' airfares); this displays a unique duopolistic aviation market structure. This study illustrates duopolistic price reaction between a FSC and a LCC in New Zealand's domestic aviation market. The results show that both carriers reacted to each other's airfares to capture domestic passenger traffic but do not provide a conclusive indication of pricing predation.

The remainder of this paper is structured as follows. Section 2 reviews the background of airline development and activities in New Zealand's domestic aviation market and the development of LCCs. Section 3 provides a review of pricing behaviour, including price competition and price dispersion in the airline industry. Section 4 describes the methodology used in this study and presents the dataset for analysis. Section 5 reports and discusses the results. The study concludes its key findings and indicates a direction for further research in Section 6.

2. Background

New Zealand is at the forefront of deregulation domestically but the 'low-cost revolution' has been slow to develop (Kissling 1998). In 1996, the first LCC entered New

Zealand's aviation market and had a minimal market share (Francis et al. 2006). Benefitting from the 'open skies' agreement between Australia and New Zealand, Jetstar (the subsidiary of Qantas) was the first LCC to start scheduled domestic flight services in New Zealand's major cities in June 1996. Jetstar later extended its operations to New Zealand's smaller regions (Tsui 2017; Wang et al. 2020). This was an important development for New Zealand's domestic aviation sector.

New Zealand's domestic aviation market is dominated by Air New Zealand, a FSC that offers flight services to 20 different domestic destinations (Air New Zealand 2020), and Jetstar, a LCC serves fewer domestic destinations. Jetstar started to offer budget air transport services to New Zealand's major cities, namely Auckland, Christchurch, Dunedin, Queenstown, and Wellington. It also adopted aggressive marketing strategies to extend its scheduled budget flight services to four additional smaller regional airports/cities, namely Nelson, Napier, New Plymouth, and Palmerston North, between December 2015 and February 2016. This suggests that Jetstar broke Air New Zealand's stronghold on the regional markets when it expanded its main domestic trunk route networks to regional route networks in New Zealand. This caused a sharp drop in fares and benefited regional tourism. Thus Jetstar has built a strong position in New Zealand since its inception. Hazledine (2011a) mentioned that Air New Zealand faces competition and challenges in its domestic markets because of the continued competitive threat from the LCC business model. Similar comments were made by Mr. Phil Twyford of the New Zealand Labour Party (the Minister for Economic Development and Urban Development and Transport of the current New Zealand government) that "*Jetstar's plans to step up with extra services is a great opportunity to make the most of the competition, and use that pressure to drive fares down for all New Zealanders*" (The Labour Party 2015).

Currently, a unique characteristic of New Zealand's domestic aviation industry is the presence of two major airlines (Air New Zealand and Jetstar) and a few very small carriers (e.g. Air Chathams, Origin Air and Sounds Air).[1] In 2019, Air New Zealand remained the dominant airline in New Zealand's domestic aviation market, with 81.06% of total scheduled domestic seat capacity and 77.69% of total scheduled domestic flights; Jetstar operated with shares of 16.60% and 10.91%, respectively. These two airlines collectively accounted for around 99% of New Zealand's domestic airline market in 2019 (Henderson et al. 2019). Other smaller carriers in New Zealand only accounted for approximately 2.34% of total scheduled domestic seat capacity and 11.40% of total scheduled flights during the same year (Official Airline Guide 2022). This implies that Air New Zealand is a dominant power in New Zealand's domestic aviation market.

As of 16 October 2019, Jetstar announced its withdrawal from some of its New Zealand's domestic regional route networks (i.e. Auckland to/from Napier, Nelson, New Plymouth, and Palmerston North, and Wellington to/from Nelson) from 1 December 2019 because of lower passenger demand on regional routes which could not financially sustain Jetstar's regional operations (see also Table 1). This withdrawal reduced the number of Jetstar's domestic routes from nine to five (Jetstar 2019). This is a recent significant development in New Zealand's domestic aviation market and indicates Jetstar's decision on positioning and presence in some of New Zealand's regional centres.

Table 1. Examined domestic routes operated by Air New Zealand and Jetstar in 2019.

Type of route	Airport-pair	Distance (km)	*NZfreq*	*JQfreq*
Trunk routes	Auckland – Christchurch	480	73.83	6.24
	Auckland – Wellington	1,024	58.05	5.02
	Auckland – Queenstown	304	56.39	3.00
	Christchurch – Wellington	346	59.28	3.52
	Wellington – Queenstown	1,061	62.36	2.33
Secondary routes	Auckland – Dunedin	327	67.46	1.04
	Auckland – Napier/Hastings[WD]	229	59.12	2.58
	Auckland – New Plymouth[WD]	494	53.72	1.20
	Auckland – Nelson[WD]	375	66.83	2.47
	Auckland – Palmerston North[WD]	327	58.63	2.32
	Christchurch – Napier/Hastings	517	69.23	2.02
	Christchurch – New Plymouth	251	68.23	2.09
	Wellington – Dunedin	270	65.59	1.37
	Wellington – New Plymouth	132	58.25	1.42
	Wellington – Nelson[WD]	129	62.50	3.61
	Queenstown – Napier/Hastings	805	66.78	1.08
	Queenstown – Nelson	768	65.12	1.35
	Queenstown – Palmerston North	745	64.37	1.33

Notes: *NZfreq* and *JQfreq* indicate the average number of flights of Air New Zealand and Jetstar in a certain route during the examined period, respectively. Superscript WD indicates a flight route being withdrawn by Jetstar from 1 December 2019.

As mentioned above, to the best of authors' knowledge, there are no specific studies have empirically investigated the airline price reaction of New Zealand's duopolistic domestic aviation market, although Jetstar has been serving New Zealand's domestic aviation market since 2009. According to Henderson et al. (2019), because air travellers are mainly facing a choice between only these two major carriers in New Zealand's domestic aviation market, examining this airline market allows us to understand the dichotomous choice of air travellers between a FSC and a LCC. Note that this setting was scanty examined in the literature, since most of them focused on the US or European markets (Avogadro et al. 2021; Kuljanin et al. 2021; Soyk, Ringbeck, and Spinler 2021), mainly due to data availability. Note also that in these markets, the existence of many airlines will make the picture of price competition/reaction more complicated, while the airfare reactions in the New Zealand domestic market with only two major airlines (FSC *versus* LCC) would be more appealing. This seemingly duopolistic structure in New Zealand's domestic aviation market prompts this study to empirically explore price reaction between two major carriers serving and capturing domestic passenger traffics. Importantly, this unique situation (i.e. the duopolistic market) is not attainable or not commonly found in other aviation markets, which might have more competition among carriers. Therefore, this study offers a detailed empirical analysis of price reaction between two carriers (FSC *vs*. LCC) in New Zealand's duopolistic domestic aviation market.

3. Literature review

There is a significant body of literature on airline pricing and intramodal competition (among airlines) on airfare. Oliveira (2008) claimed that competition between rapidly expanding LCC and FSCs has become the most relevant issue of the airline industry. There is an extensive body of literature on the airline pricing competition between airlines (Gorin and Belobaba 2008; Obermeyer, Evangelinos, and Püschel 2013; Zhang, Derudder, and Witlox 2013; Bilotkach, Gaggero, and Piga 2015). This stream of the literature has focused on the reactions of FSCs to competition from LCCs. In the airline pricing literature, Hazledine (2011a) analysed pricing and product differentiation in modern airline marketing using the cases of two national carriers (Air New Zealand and Air Canada) which faced competition from LCCs. Hazledine (2011b) also explored the oligopolistic pricing behaviour in New Zealand's domestic and trans-Tasman air travel markets of Air New Zealand, Qantas, and Virgin Blue. In addition, Gillen and Hazledine (2015) attempted to identify the determinants of service and pricing on regional routes in Australia, Canada, New Zealand, Norway, Sweden and three US states. The key findings of the study showed the strong effects of competition on price are different between regional and main trunk route pricing. A later study of Gillen and Hazledine (2016) found similar evidence of strong effects of competitions on fares and few systematic differences between regional and main trunk route pricing while analysing airfares offered on regional routes of New Zealand and Eastern Australia from 2011 to 2015.

In addition, several studies (Perry 1995; Dresner, Lin, and Windle 1996; Goolsbee and Syverson 2008; Malighetti, Paleari, and Redondi 2009) have focused on airline markets with low-fare new entrant competition. In particular, Perry (1995) concluded that the typical impact of LCCs at the local market level is an increase in total traffic, a decrease in average market fares and an increase in total market revenues. For incumbent carriers, this translates into a decrease in average fares, a decrease in revenues (as a LCC increases its own revenues) and an increase in its local traffic. Similarly, Gorin and Belobaba (2008) offered similar evidence that the entry of LCCs usually leads to: (i) an increase in total local market traffic and incumbent carriers' local traffic; (ii) a decrease in average fares, both at the market level and for incumbent carriers; (iii) an increase in total aircraft departures in the market; and (iv) an increase in total market revenues. Importantly, Goolsbee and Syverson (2008) asserted that incumbent carriers cut fares significantly when threatened by the entry of LCCs. Recently, Costantino et al. (2016) conducted an extensive and complete literature review on LCCs' pricing strategies and practices in an attempt to identify the current and modern trends of LCCs' pricing competition and future research directions.

Other authors have been interested in predatory pricing. Most previous empirical work on this topic – as on the airline market in general – has focused on the US domestic aviation market. Dodgson, Katsoulacos, and Pryke (1991) provided a definition of predatory practices in the airline industry and concepts of relevance in identifying these practices. Although many prior studies indicated a growing concern with respect to unfair competition and predatory pricing, and how they affected competition. Dixit et al. (2006) also offered a definition of predatory pricing through an examination of the US Supreme Court's decision on such predatory conduct in the marketplace. The Supreme Court in the US defined predatory pricing as "*pricing below an appropriate measure of cost for the purpose of eliminating competitors in the short run and reducing competition in the long run*" (172). Empirically, Oster and Strong (2001) examined the potential for predatory practices or unfair methods of competition in the US domestic airline industry. Gorin and Belobaba (2008) also assessed unfair competitive practices in the US airline markets based on an analysis of changes in average fares, revenue and traffic following the entry of LCCs. Similarly, Morrison (2004) discussed the dimensions of predatory pricing in air travel markets in Germany while Khan et al. (2019) explored the evolving competition between FSCs and LCCs in South Korea.

It is important, however, to note that prior studies examined the airline pricing competition by using price dispersion (i.e. the differences in prices between the based airline and the rest) in either multi-route settings (Mantin and Koo 2010; Obermeyer, Evangelinos, and Püschel 2013; Bilotkach, Gaggero, and Piga 2015; Luttmann 2019) or in single-route settings (Pels and Rietveld 2004; Narangajavana et al. 2014; van den Bogaard and Lijesen 2019). Studies on both settings have been conducted in competitive markets with several airlines, normally involving FSCs and LCCs, and so price dispersion is an appropriate approach to analysing airline pricing competition since many airlines' prices are involved. Nevertheless, when examining a duopolistic aviation market with only two major airlines, the basic economic theory looks at the airfares of two airlines as a system of the demand and supply functions of two airlines in which both airlines can react to each other simultaneously (i.e. the Bertrand model) or sequentially (i.e. the Stackelberg model). The basic idea of those models is that equilibrium is achieved when the prices of two airlines are equal to each other and to the marginal cost, whereas the number of passengers who purchased air tickets can be derived later from this equilibrium price (Mankiw 2020). These models, however, require information on both the prices (e.g. airfares) and quantity of the outputs (e.g. passenger numbers)[2] as well as the airlines' cost structure and several other controlling factors such as advertisement or the degree of product differentiation for the construction of the demand and supply equations (Tremblay and Tremblay 2011; Naimzada and Tramontana 2012). Those requirements in turn limit the number of empirical applications on price competition in the airline market. Since the domestic aviation market in New Zealand is a natural case of a duopolistic market, in which the price reaction issue may be clearer than in other markets, this study empirically investigates the reaction of airline prices between the two major airlines (Air New Zealand and Jetstar) in New Zealand.

4. Methodology and data

4.1. Empirical model and variables of interest

This study aims to analyse the price reaction of Air New Zealand and Jetstar in New Zealand's duopolistic domestic aviation market, focusing on whether these two major airlines compete and react on each other's airfare (fare competition) and which determinants have affected their respective fares. It should be noted that this study follows neither the traditional Bertrand model nor the Stackelberg model (Mankiw 2020) because the demand and supply models for the two sampled airlines could not be established because the data on the number of passengers who actually booked or purchased air tickets at the particular fares from each airline were not available during the time of data collection (i.e. 21 days before the flight departure date). This study, therefore, follows Stahl (1989), Hviid and Shaffer (1999), and Pels and Rietveld (2004) to use the price matching framework in examining the reaction between the two ticket prices of Air New Zealand and Jetstar serving in New Zealand's duopolistic domestic aviation market in a system of price equations. Particularly, the price matching framework argues that in a competitive market, firms react to each other to set their prices equal to attract customers i.e. $P_1 = P_2 = \ldots = P_n$. It should be also noted that previous studies on price dispersion (Luttmann 2019; van den Bogaard and Lijesen 2019) generally argued that $Price\_Dispersion = f(Independent\_Variables)$, in which $Price\_Dispersion = P_2 - P_1$. A simple modification of the price dispersion model suggests that $P_1 = f(P_2,\ Independent\_Variables)$, and *vice versa*, $P_2 = g(P_1,\ Independent\_Variables)$. The combination of the price dispersion and the price matching models give us the basic idea for this study – in this sense, our study can also be seen as an extension of the price dispersion literature.

Specifically, this study assumes that Air New Zealand's fares (*NZ*) reacts to those of Jetstar (*JQ*), and *vice versa*. The simultaneous-equation system of Equations (1) and (2) is established,[3] in which if an airline (*NZ* or *JQ*) significantly changes its fares for a particular route, the other airline (*JQ* or *NZ*) is likely to match its fares. Specifically, Equation (1) implies that the airfares of Air New Zealand (*NZfare*) is a function of Jetstar's airfares (*JQfare*), whereas *JQfare* is obviously an endogenous variable represented by Equation (2), in which *JQfare* is also a function of *NZfare*. This system potentially suffers from the endogeneity problem since airfares do not only depend on the observable factors such as the competitor's airfares, fuel prices, and flying distance, but also the unobservable ones, for our dataset, such as passenger's demand, travel purpose, airline preference and loyalty. To account for this problem, we follow the literature (Zhang and Round 2009; Gaggero and Piga 2010; Lurkin et al. 2017) by adopting the instrumental variable (IV) technique to account for the unobserved factors influencing airline prices that have not been addressed by the airline prices themselves. Mumbower, Garrow, and Higgins (2014) summarized the four possible sources of IVs to address the problem of endogeneity in estimating airline applications, of which the Stern-type measure of competition (Stern 1996) has been popularly used in Lurkin et al. (2017), Guerrero et al. (2021), and Li, Li, and Ma (2021), among others. Since we have only two airlines involved, and because the calculation of a Herfindahl index requires additional data (Fu et al. 2021; Soyk, Ringbeck, and Spinler 2021), we, therefore, follow Obermeyer, Evangelinos, and Püschel (2013) and Mumbower, Garrow, and Higgins (2014) to use the number of daily flights that Air New Zealand and Jetstar operated on each city-pair route (regardless of the matched fares) as IVs for their airfares, respectively. The differences in flight frequency of the two sampled airlines still exhibit the competition level (and market shares) between them. In this sense, the variable $\ln(JQfreq)$ in Equation (1) is excluded from Equation (2), while the variable $\ln(NZfreq)$ in Equation (2) is excluded from Equation (1); we thus have our system just identified.

Note that Equations (1) and (2) indicate how an airline defines its prices, and thus, those equations can represent the cost function of the firm. Shephard (1970), Caves and Christensen (1980), and Röller (1990), among other seminal papers, have argued that the quadratic function is a proper non-linear form of the cost function that satisfy several properties (e.g. homogeneity and concave). In the aviation sector, there is evidence that airlines dynamically set airfares depending on the price elasticity of demand, and the difference in passenger demand (for FSCs and LCCs) can also be represented by a U-shaped price curve (Alderighi, Nicolini, and Piga 2015b; Varella, Frazão, and Oliveira 2017). One may argue that the quadratic function is sensitive to outlier(s), and a higher degree of the powers of the independent variables the better fit for the estimation. However, we believe that the former issue exists in all polynomial functions, so the use of a quadratic function in this study is no worse-off than the other forms. More importantly, using higher degree of powers may overfit the data, as John von Neumann once said: “with four parameters I can fit an elephant, and with five I can make him wiggle his trunk” (Dyson 2004). The quadratic function, therefore, is suitable to capture the non-linear relationship between the airfares of Air New Zealand and Jetstar in New Zealand’s duopolistic domestic aviation market. Thus, the system equations are presented in Equations (1) and (2):

$$\begin{aligned}\ln(NZ\,fare) = {} & \alpha_0 + \alpha_1\ln(JQ\,fare) + \alpha_2\ln(JQ\,fare^2) + \alpha_3\ln(JQ\,freq) + \alpha_4\ln(Distance) \\ & + \alpha_5\ln(Fuel) + \alpha_6 JQwithdrawal + \alpha_7 Holidays + \alpha_8 AM + \alpha_9 PM \\ & + \alpha_{10} Tuesdays + \alpha_{11} Wednesdays + \alpha_{12} Thursdays + \alpha_{13} Fridays \\ & + \alpha_{14} Saturdays + \alpha_{15} Sundays + \varepsilon_{NZ} \end{aligned} \tag{1}$$

$$\begin{aligned}\ln(JQ\,fare) = {} & \beta_0 + \beta_1\ln(NZ\,fare) + \beta_2\ln(NZ\,fare^2) + \beta_3\ln(NZ\,freq) + \beta_4\ln(Distance) \\ & + \beta_5\ln(Fuel) + \beta_6 JQwithdrawal + \beta_7 Holidays + \beta_8 AM + \beta_9 PM \\ & + \beta_{10} Tuesdays + \beta_{11} Wednesdays + \beta_{12} Thursdays + \beta_{13} Fridays \\ & + \beta_{14} Saturdays + \beta_{15} Sundays + \varepsilon_{JQ} \end{aligned} \tag{2}$$

where α and β denote the constants, the subscript β_i denotes the coefficients to be estimated, and ε_{NZ} and ε_{JQ} denote the error terms. The statistical program of Stata 16 was used for estimation, where the three-stage least squares (3SLS) technique was employed thanks to its advantages compared to the other techniques in estimating the simultaneous-equations system (see also Pitfield, Caves, and Quddus 2010; Ngo and Le 2019; Tsui et al. 2019; Kuljanin et al. 2021). Compared to the two-stage least squares (2SLS) approach, for example, Belsley (1988) emphasized that for a system with two equations (which is similar to our study), the 3SLS is more efficient because it can capture the pairwise interrelation among the error terms of the two equations.

In this simultaneous-equations system, $\ln(NZ\,fare)$ denotes the quoted fare (in NZ$) of Air New Zealand for a flight between two New Zealand domestic airports. $\ln(JQ\,fare)$ denotes the matched fare (in NZ$) of Jetstar for a flight between the same two airports.[4] $\ln(NZ\,fare^2)$ and $\ln(JQ\,fare^2)$ denote the squared values of $\ln(NZ\,fare)$ and $\ln(JQ\,fare)$, respectively. $\ln(NZ\,freq)$ and $\ln(JQ\,freq)$ are the logarithmic values of the daily number of flights for a certain city-pair route on a certain date for Air New Zealand and Jetstar, respectively. $\ln(Distance)$ is the flying distance between two New Zealand airports (in km). It has been argued that longer flying distance affects airline cost structure (De Roos, Mills, and Whelan 2010; Mantin and Koo 2010; Zhang, Derudder, and Witlox 2013). $\ln(Fuel)$ is the jet fuel price (NZ$/gallon), which is also a key factor impacting airlines’ operating costs (De Roos, Mills, and Whelan 2010; Scotti and Volta 2018). *JQwithdrawal* is a dummy variable that captures the impact of

Jetstar's withdrawal from regional airports and cities that takes a value of 1 for dates prior to 1 December 2019 and 0 otherwise.

Holidays is a dummy variable that captures the impacts of school holidays (28 September–13 October 2019) and New Zealand's annual public holiday (Labour Day on 28 October 2019) on domestic air travel demand and, consequently, on airline pricing, which takes a value of 1, and 0 otherwise. Note that these control variables were also included and examined by De Roos, Mills, and Whelan (2010) and Bilotkach, Gaggero, and Piga (2015), among others. *AM* and *PM* denote morning and afternoon flight departures, with evening flights are treated as the base model. These two dummy variables capture both airlines' fares for morning flights (*AM* takes a value of 1 if the flight departs before 12 noon and 0 otherwise), and afternoon flights (*PM* takes the value of 1 if the flight departs between 12 noon and 5:00pm, and 0 otherwise). Alderighi, Gaggero, and Piga (2015a) and Avogadro et al. (2021) found that the ticket prices of afternoon and evening flights of LCCs tend to be lower than morning ones. In addition, airfare differences depend on the flight departure time under the effects of systematic peak load pricing but also on a daily basis (see also Bilotkach, Gaggero, and Piga 2015). Therefore, to compare with the base date of Mondays, the dummy variables of *Tuesdays*, *Wednesdays*, *Thursdays*, *Fridays*, *Saturdays* and *Sundays* are established to indicate the flight departure dates, aiming to capture the departure date effect and the weekend effect (i.e. Fridays, Saturdays and Sundays)[5] on both airlines' fares. There is evidence that passengers and travellers have different preferences regarding their travel date and thus airfares need to be adjusted to match air travel demand accordingly (Mantin and Koo 2010).

Since Equations (1) and (2) are in quadratic forms, one can easily compute the value of $\ln(NZ\,fare)$ and $\ln(NZ\,fare)$ that make those quadratic functions reach their maximum (if the coefficients of the quadratic variables is negative) or minimum values (if such coefficients is greater than zero):

$$\ln(JQ\,fare)_{\min/\max} = -\alpha_1/(2 * \alpha_2) \tag{3}$$

$$\ln(NZ\,fare)_{\min/\max} = -\beta_1/(2 * \beta_2) \tag{4}$$

Consequently,

$$JQ\,fare = \exp[\ln(JQ\,fare)_{\min/\max}] \tag{5}$$

$$NZ\,fare = \exp[\ln(NZ\,fare)_{\min/\max}] \tag{6}$$

4.2. Data collection and processing

This study extracted the information on the domestic airfare data for Air New Zealand and Jetstar from the dataset provided by Ho et al. (2021). Unlike previous studies, which collected airfare data on a daily basis, whereas airfares are collected once a day as either the highest or lowest prices of the day (Mantin and Koo 2010; Bilotkach, Gaggero, and Piga 2015) or the average daily prices (Zhang, Derudder, and Witlox 2013), this dataset allows us to use the fares for all the sampled New Zealand domestic routes operated by both airlines (at different times of a day), which provides more observations and helps explain the competition between Air New Zealand and Jetstar in more details.[6] As mentioned above, New Zealand's domestic aviation market is relatively small and is dominated by two major airlines (Air New Zealand and Jetstar); in fact, this study assumes that price competition between these two major airlines in new Zealand's domestic market, if any, should happen at any time of the day, and that both airlines should frequently adjust their respective fares to attract prospective passengers in such a competitive duopolistic aviation landscape.

Specifically, our data includes the (seat and bag) airfares of Air New Zealand and Jetstar for nine New Zealand domestic routes (see Table 1) for the period of 16 September 2019–16 December 2019 (a total of 92 days). This study period captures the withdrawal of Jetstar from several regional routes from 1 December 2019 (see Section 2), and therefore it helps identify the impact of Jetstar's withdrawal on future bookings by travellers flying within New Zealand. Since the summer holidays in New Zealand starts from mid-December to early February of the following year (Ministry of Education 2019), our study is not affected by this seasonal effect. More importantly, even if the effect exists, it will have the same impacts on both airlines/airfares, such that their price reactions would still be consistent. For the estimation purposes, all the collected data and information were sorted to match the airfares of Air New Zealand and Jetstar based on the same routes (so that the two prices can react to each other) within a predetermined departure time window. For example, with a 60-min window, for the route from Auckland to Christchurch, a 7:00 am Air New Zealand flight was matched with 6:00 am and 8:00 am Jetstar flights, and so two observations between Air New Zealand and Jetstar were generated for analysis. Note that this study uses five different departure time windows to represent different levels of temporal competition between Air New Zealand and Jetstar in serving New Zealand's domestic aviation market: a 5-minute window (29,923 observations), a 15-minute window (32,862 observations), a 30-minute window (40,140 observations), a 45-minute window (46,595 observations) and a 60-minute window (53,463 observations). Logically, price reaction and competition would be more intense in smaller time-windows given that air travellers need to make their decisions quickly upon a fewer flight availability, in which the airfares would become the most important factor.

In addition, this study compares pricing competition between both airlines for domestic trunk and secondary routes. Trunk routes refer to the routes involving the four key largest New Zealand airports (Auckland, Christchurch, Queenstown, and Wellington airports). Secondary routes refer to the routes which involved smaller regional New Zealand airports (Nelson, Napier, New Plymouth, and Palmerston North airports). One-way airfares for all flights departing from the four major airports (i.e. Auckland, Christchurch, Queenstown, and Wellington airports) to smaller secondary airports (Dunedin, Napier-Hastings, New Plymouth, Nelson, and Palmerston North airports) were examined. In total, six trunk routes and 12 secondary routes were included in this study (see Table 1). As pointed out by Luttmann (2019), the use of one-way or directional airfares will help increase the number of routes being investigated; for instance, the routes of Auckland–Wellington and Wellington–Auckland are considered as two independent observations. It is also noted that since New Zealand is a small island country, transit flights or stopovers are normally not required and are uncommon while flying domestically, so the dataset only contained Air New Zealand and Jetstar domestic direct flights.

Table 2. Descriptive statistics of domestic airfares (NZ$) for Air New Zealand and Jetstar by departure date, time, and route.

	Mondays	Tuesdays	Wednesdays	Thursdays	Fridays	Saturdays	Sundays
Air New Zealand (NZ)							
Number of observations	8,936	8,088	7,768	7,192	6,794	7,157	7,528
Mean	362.78	371.72	401.60	427.59	450.22	436.16	384.21
Standard deviation	138.03	145.62	137.24	147.94	169.11	162.15	146.04
Minimum	63	63	73	63	63	83	73
Maximum	998	1,343	956	1,343	1,343	1,343	1,343
Jetstar (JQ)							
Number of observations	8,936	8,088	7,768	7,192	6,794	7,157	7,528
Mean	130.73	143.30	164.91	197.97	186.63	175.56	163.43
Standard deviation	76.99	83.31	83.57	103.64	102.10	110.06	105.45
Minimum	32	36	36	32	36	36	36
Maximum	459	454	478	642	613	616	727

	AM	PM	Evening/Night	Holidays	Trunk routes	Secondary routes	All sample
Air New Zealand (NZ)							
Number of observations	39,031	12,101	2,331	11,671	36,302	17,161	53,463
Mean	405.57	401.08	357.10	420.67	403.10	401.06	402.44
Standard deviation	149.46	161.71	142.37	154.58	148.50	160.16	152.34
Minimum	63	63	73	73	63	63	63
Maximum	1,343	1,343	925	1,343	1,343	1,109	1,343
Jetstar (JQ)							
Number of observations	39,031	12,101	2,331	11,671	36,302	17,161	53,463
Mean	169.13	153.94	138.38	163.21	144.78	205.75	164.35
Standard deviation	99.21	94.77	69.40	93.04	86.35	106.29	97.46
Minimum	32	32	45	36	32	36	32
Maximum	642	727	386	616	727	616	727

Apart from collecting the airfare and related data to investigate variations in the domestic airfares of Air New Zealand and Jetstar in New Zealand, to control for the possible impacts of other observable factors, this study also collected information on the flying distance between New Zealand airports from the Official Airline Guide and jet fuel prices from the US Energy Information Administration. Table 2 presents the descriptive statistics of the variables of interest for estimation.

The number of observations (i.e. matched fares quoted for a 60-minute window) for Air New Zealand and Jetstar ranged from 6,794 observations on Fridays to 8,936 observations on Mondays. The average airfare ranges from NZ$362.78–NZ$450.22 for Air New Zealand and from NZ$130.73–NZ$197.97 for Jetstar, respectively. The average airfare difference between the two sampled airlines is NZ$238.09, which suggests that Air New Zealand's airfares (as a FSC) are nearly 2.5 times higher than those of Jetstar (as a LCC). In addition, Air New Zealand sold a significant higher airfare to passengers travelling on Thursdays, Friday, and Saturdays, whereas Jetstar's airfares for those days are also higher but not substantially different from its airfares on other days. When comparing the average airfares sold at different departure times of the day, morning flights seemed to be the most expensive, follows by the afternoon and then evening flights. Compared to the whole-period average airfare, while Air New Zealand tends to sell their tickets at a higher price during the holidays (i.e. school holidays and Labour Day), this action is not observed in Jetstar. Furthermore, Air New Zealand's airfares were similar across trunk and secondary routes, whereas Jetstar's airfares were higher on secondary routes and cheaper on trunk routes during the study period.

Table 3. Estimation results for price reaction between Air New Zealand and Jetstar (all routes and time-windows).

Dependent variable	ln(*NZfare*)		ln(*JQfare*)	
Independent variable	Coefficient	Standard error	Coefficient	Standard error
ln(*NZfare*)			200.19***	6.85
ln ($NZfare^2$)			−17.28***	0.59
ln(*NZfreq*)			−1.06***	0.10
ln(*JQfare*)	−154.68***	12.24		
ln ($JQfare^2$)	15.68***	1.24		
ln(*JQfreq*)	1.11***	0.10		
ln(*Distance*)	1.68***	0.14	−0.13***	0.04
ln(*Fuel*)	7.52***	0.70	−0.38	0.24
JQwithdrawal	0.44***	0.12	−0.21**	0.09
Holiday s	0.47***	0.07	0.26***	0.05
AM	−0.68***	0.15	−0.39***	0.10
PM	−0.76***	0.15	0.16	0.10
Tuesday s	0.84***	0.11	0.16**	0.07
Wednesday s	1.82***	0.17	0.01	0.07
Thursday s	0.87***	0.11	0.58***	0.07
Friday s	1.29***	0.13	1.39***	0.08
Saturday s	0.73***	0.11	1.01***	0.08
Sunday s	−0.02	0.10	0.34***	0.07
Constant	347.95***	27.09	−565.49***	19.49
χ^2	178.51		936.49	
Observations	53,463		53,463	

Notes: *, ** and *** indicate that the explanatory variable is significant at the 0.10, 0.05 and 0.01 significance levels, respectively.

5. Empirical results and discussions

This section first presents the estimation results of the 3SLS models for investigating the price reaction between Air New Zealand and Jetstar in New Zealand's duopolistic domestic market. We have also run our models using other techniques such as the two-stage least square (2SLS) and seemingly unrelated regression (SUR); the results are consistent with those from 3SLS and are therefore not reported. The key results are summarised and discussed accordingly.

5.1. Price reaction between air New Zealand and jetstar: at a glance

Our base model used all data available regardless of the time-window or type of route, i.e. 53,463 observations. The results reported in the first part of Table 3 (i.e. columns 2 and 3) show that Air New Zealand's fares (ln(*NZ fare*)) are negatively associated with Jetstar's fares (ln(*JQ fare*)) but are positively impacted by the quadratic value of Jetstar's fares (ln($JQ fare^2$)). It suggests that the influence of Jetstar's airfares on Air New Zealand's airfares follows a U-shape pattern. That is, when Jetstar's airfares increase, Air New Zealand will decrease its airfares to gain more competitive power. However, if Jetstar's ticket price rises above NZ$138.83 (derived from Table 3 using Equations (3) and (5)), Air New Zealand will start to increase its fares as well. During the examined period, we observe that Air New Zealand fairly reacts to Jetstar's airfares since the FSC has 26,992 price points on the left side and 26,471 points on the right side of the parabola, respectively. In contrast, the second part of Table 3 (columns 4 and 5) shows that Jetstar's airfares (ln(*JQ fare*)) are positively associated with ln(*NZ fare*), but negatively associated with ln($NZ fare^2$). In this sense, the impact of Air

New Zealand's airfares on Jetstar's follows an inverted U-shape pattern. Specifically, when Air New Zealand increases its prices, Jetstar will first also increase its airfares. When Air New Zealand's airfares are greater than NZ$327.91 (derived from Table 3 using Equations (4) and (6)), Jetstar will start to reduce its fares. For the case of Jetstar, there are more price points on the right side of the parabola than those on the left (i.e. 37,022 *versus* 16,441), suggesting that the LCC reacts more frequently to reduce its airfares in order to gain more competitiveness. These two patterns reveal the difference in the two business models of Air New Zealand (as a FSC) and Jetstar (as a LCC), where prices are not allowed to be too low for FSCs or too high for LCCs, such a 'head-to-head' price competition between the two airlines is not advisable, and price reaction therefore has a limitation (Flouris and Walker 2005; Morrell 2005; Khan et al. 2019). Combine with the wide ranges of prices of the two airlines as summarized in Table 2, one can argue that price reaction and competition between them are fierce. We then proceed to examine for such price reaction in more details, regarding different types of routes and different time-windows – the results are presented in the following sections.

5.2. Price reaction at different routes and time-window levels

Regarding the trunk routes (see Tables 4A and 4B), estimation results for Air New Zealand are shown in Table 4A whilst those for Jetstar are presented in Table 4B. Here, the story for trunk routes is different from the overall picture observed from the previous section, especially for Air New Zealand: we found that the inverted U-shape relationship exists in both directions, i.e. from Air New Zealand to Jetstar and from Jetstar to Air New Zealand. In other words, when Air New Zealand (or Jetstar) increase its airfares, Jetstar (or Air New Zealand) will follow to increase its fares up to a certain level then starts to reduce them. While the LCC model of Jetstar requires it to reduce the fares after its reach a maximum level, it is understandable that Air New Zealand also behaves in a similar manner, although it does not follow the LCC model. In fact, Air New Zealand has been adopting a hybrid model of a 'low-fares airline' (Lawton and Solomko 2005; Hazledine 2011a) rather than strictly following the FSC model, and thus reducing airfares after the maximum level is reached is reasonable for the incumbent airline. Such U-shape patterns exist in all time-windows of Table 4, suggesting that on trunk routes, the two airlines closely follow each other to monitor their own airfares as well as their competitor's. Among them, Air New Zealand reacts more during a 15-minutes window with the largest values of the coefficients on ln(*JQ fare*) and ln $(JQ\,fare^2)$ are 194.97 and -20.10 (see Table 4A), respectively; while Jetstar reacts more during a 60-minutes window with the largest values of the coefficients on ln(*NZ fare*) and ln $(NZ\,fare^2)$ are 167.80 and -14.55 (see Table 4B), respectively. We argue that a higher availability of Air New Zealand flights on trunk routes allow it to react more flexibly with even a small time-window, whereas a lower flight frequency only allows Jetstar to react better with large time-window. In contrast, the less reactions period for Jetstar is the 15-minutes window and for Air New Zealand is the 60-minutes window.

Table 4A. Estimation results of Air New Zealand's fares for trunk routes.

	Dependent variable: ln(*NZfare*)									
	5-minute window		15-minute window		30-minute window		45-minute window		60-minute window	
Explanatory variables	Coefficients	Standard error	Coefficients	Standard error	Coefficients	Standard error	Coefficients	Standard error	Coefficients	Standard error
ln(*JQfare*)	194.97***	50.57	184.68***	46.79	148.86***	35.70	71.01***	20.42	133.28***	35.64
ln ($JQfare^2$)	−20.10***	5.22	−19.02***	4.82	−15.28***	3.67	−7.27***	2.09	−13.65***	3.65
ln(*JQfreq*)	−3.59***	0.96	−3.25***	0.85	−2.65***	0.66	−1.16***	0.36	−2.32***	0.65
ln(*Distance*)	−2.51***	0.66	−2.46***	0.63	−1.97***	0.48	−1.04***	0.30	−1.94***	0.51
ln(*Fuel*)	−12.40***	3.25	−11.63***	2.97	−9.11***	2.19	−4.24***	1.20	−7.87***	2.09
JQwithdrawal	−1.37***	0.33	−1.34***	0.31	−1.33***	0.28	−0.78***	0.16	−1.27***	0.29
Holidays	−0.58***	0.20	−0.59***	0.20	−0.56***	0.17	−0.24**	0.09	−0.52***	0.17
AM	0.65*	0.34	0.54**	0.26	0.59***	0.20	0.31***	0.08	0.39***	0.13
PM	0.89**	0.40	0.87**	0.33	0.74***	0.24	0.35***	0.11	0.48***	0.16
Tuesdays	−1.73***	0.49	−1.58***	0.44	−1.26***	0.33	−0.62***	0.19	−1.14***	0.33
Wednesdays	−3.17***	0.87	−3.00***	0.81	−2.40***	0.62	−1.14***	0.37	−2.25***	0.64
Thursdays	−2.21***	0.64	−2.14***	0.61	−1.67***	0.46	−0.79**	0.28	−1.70***	0.51
Fridays	−2.44***	0.70	−2.37***	0.66	−2.01***	0.53	−0.92***	0.31	−1.83***	0.54
Saturdays	−2.73***	0.77	−2.44***	0.68	−1.84***	0.49	−0.83***	0.28	−1.72***	0.51
Sundays	−2.01***	0.56	−1.84***	0.50	−1.15***	0.31	−0.59***	0.19	−1.17***	0.33
Constant	−401.77***	105.69	−380.70***	97.91	−307.76***	75.20	−143.87***	43.05	−275.23***	75.22
χ^2	23.59		25.49		33.28		85.56		36.29	
Observations	21,938		23,897		28,162		31,931		36,302	

Notes: *, ** and *** indicate that the explanatory variable is significant at the 0.10, 0.05 and 0.01 significance levels, respectively.

Table 4B. Estimation results of Jetstar's fares for trunk routes.

	Dependent variable: ln(*JQfare*)									
	5-minute window		**15-minute window**		**30-minute window**		**45-minute window**		**60-minute window**	
Explanatory variables	**Coefficients**	**Standard error**	**Coefficients**	**Standard error**	**Coefficients**	**Standard error**	**Coefficients**	**Standard error**	**Coefficients**	**Standard error**
ln(*NZfare*)	152.67***	7.53	156.04***	7.45	160.31***	7.03	165.46***	6.83	167.80***	6.40
ln ($NZfare^2$)	−13.31***	0.66	−13.57***	0.65	−13.92***	0.61	−14.36***	0.59	−14.55***	0.56
ln(*NZfreq*)	0.12	0.11	0.03	0.10	−0.08	0.10	−0.09	0.09	−0.15**	0.09
ln(*Distance*)	0.06	0.06	0.14**	0.06	0.10*	0.06	0.04	0.05	−0.05	0.05
ln(*Fuel*)	−0.92***	0.31	−0.98***	0.30	−0.71**	0.28	−0.64**	0.27	−0.55**	0.25
JQwithdrawal	0.31***	0.11	0.30*****	0.10	0.30***	0.10	0.25**	0.09	0.23**	0.09
Holidays	0.32***	0.06	0.28***	0.06	0.29***	0.06	0.29***	0.06	0.26***	0.05
AM	−0.62***	0.17	−0.49***	0.14	−0.54***	0.12	−0.27**	0.10	−0.28***	0.09
PM	−0.41**	0.17	−0.16	0.15	−0.09	0.13	0.18	0.11	0.25**	0.09
Tuesdays	0.29***	0.09	0.26***	0.08	0.23***	0.08	0.23***	0.08	0.24***	0.07
Wednesdays	0.09	0.09	0.07	0.09	0.08	0.08	0.09	0.08	0.10	0.07
Thursdays	0.70***	0.09	0.61***	0.09	0.62***	0.08	0.63***	0.08	0.67***	0.07
Fridays	0.90***	0.10	0.86***	0.09	0.86***	0.09	0.85***	0.08	0.86***	0.07
Saturdays	0.80***	0.09	0.79***	0.09	0.76***	0.08	0.77***	0.08	0.82***	0.07
Sundays	0.49***	0.09	0.49***	0.09	0.46***	0.08	0.44***	0.08	0.45***	0.07
Constant	−428.54***	21.31	−439.03***	21.14	−452.30***	19.98	−467.39***	19.44	−473.81***	18.21
χ^2	484.78		513.75		606.13		682.34		791.56	
Observations	21,938		23,897		28,162		31,931		36,302	

Notes: *, ** and *** indicate that the explanatory variable is significant at the 0.10, 0.05 and 0.01 significance levels, respectively.

On secondary routes (see Tables 5A and 5B), the price reaction of Air New Zealand regarding Jetstar's airfares follows the U-shape patterns for all time-windows. Jetstar, on the other hand, still consistently follows the inverted U-shape pattern to react to its competitor's pricing (Air New Zealand). We can see that Air New Zealand exhibits more of its FSC characteristics on those secondary routes, compared to trunk routes. We further argue that price reaction and competition on secondary routes are being more important to Air New Zealand: the U-shape pattern on secondary routes (see Table 5A) overweight the inverted U-shape pattern on trunk routes (see Table 4A) to make the overall reaction to be U-shape (see Table 3).

Similar to the case of trunk routes, the price reaction is more pronounced for Air New Zealand in 15-minutes window and the 60-minutes window it is for Jetstar. The same argument is still valid: Air New Zealand is more flexible even with small time-windows whilst Jetstar needs large time-windows to react.[7]

5.3. Price reaction: Other determinants

The other variables in Equations (1) and (2) also play important roles to explain the airfares (and their changes) of Air New Zealand and Jetstar. This section discusses on some key findings as follows.

First, airline competition (via ln(*NZ freq*) and ln(*JQ freq*)) generally reduces airfares. For instance, the coefficients of both ln(*NZ freq*) and ln(*JQ freq*) are mainly statistically negative for across various models (whole sample or different routes/windows – see Tables 3–5B), suggesting that higher flight frequency available from the competitor leads to a reduction in airfares of the airline. Exception is the case of Jetstar on trunk routes: since it is already the lower-hand player, the marginal effect of having more flights from Air New Zealand on those routes does not affect Jetstar that much. This finding is in line with previous studies on the domestic aviation markets in Australia (Hazledine 2011b), the European countries (Malighetti, Paleari, and Redondi 2009), New Zealand (Gillen and Hazledine 2016), and the UK (Gaggero and Piga 2010). This finding therefore strengthens the evidence that airline competition brings benefits, the first and foremost is lower airfares, to air travellers; such that the promotion for airline competition in New Zealand should be continued (Gillen and Hazledine 2015; Ministry of Transport 2021).

Second, the negative impact of the flying distances, ln(*Distance*), is stronger for Air New Zealand at trunk routes and for Jetstar at secondary routes (see Tables 4A and 5B), with the larger values of statistically significant coefficients, but not for Air New Zealand at secondary routes and in general (see Tables 3 and 5A) or for Jetstar at trunk routes. In fact, the economies of scale that Air New Zealand exhibiting allows it to increase the airfares for longer routes, which in contrast maybe a barrier for the LCC model that Jetstar is operating (Luttmann 2019).

Third, a similar case is found with ln(*Fuel*) where Jetstar is more constraint while Air New Zealand is more flexible to increase its airfares given the fuel price increases, with the statistically significant and positive coefficients (particularly for secondary routes - see Table 5A) (Kuljanin et al. 2021). De Roos, Mills, and Whelan (2010) have also found such result in Australian airlines including Qantas, Virgin and Jetstar

Table 5A. Estimation results of Air New Zealand's fares for secondary routes.

	Dependent variable: ln(*NZfare*)									
	5-minute window		15-minute window		30-minute window		45-minute window		60-minute window	
Explanatory variables	**Coefficients**	**Standard error**	**Coefficients**	**Standard error**	**Coefficients**	**Standard error**	**Coefficients**	**Standard error**	**Coefficients**	**Standard error**
ln(*JQfare*)	−78.18***	7.40	−86.82***	8.34	−68.40***	4.51	−73.16***	4.85	−66.94***	3.75
ln ($JQfare^2$)	7.68***	0.73	8.56***	0.82	6.80***	0.45	7.26***	0.48	6.65***	0.37
ln(*JQfreq*)	−0.10	0.09	−0.16	0.10	−0.33***	0.07	−0.40***	0.07	−0.45***	0.06
ln(*Distance*)	0.76***	0.10	0.75***	0.10	0.46***	0.06	0.44***	0.06	0.38***	0.05
ln(*Fuel*)	4.20***	0.59	4.29***	0.61	3.18***	0.39	3.90***	0.41	3.21***	0.33
JQwithdrawal	−0.72***	0.19	−0.67***	0.20	−0.56***	0.14	−0.45***	0.14	−0.43***	0.12
Holidays	−0.06	0.08	−0.08	0.08	0.00	0.06	0.17***	0.06	0.18***	0.05
AM	−0.23	0.57	−0.12	0.29	−0.21	0.21	−0.54***	0.17	−0.47***	0.14
PM	−0.90	0.58	−0.92***	0.31	−0.85***	0.23	−1.27***	0.20	−1.20***	0.17
Tuesdays	−0.36***	0.12	−0.32**	0.13	−0.19**	0.09	−0.22**	0.09	−0.22***	0.07
Wednesdays	−0.76***	0.15	−0.69***	0.15	−0.34***	0.10	−0.36***	0.10	−0.30***	0.08
Thursdays	−1.41***	0.19	−1.47***	0.20	−1.02***	0.12	−0.99***	0.12	−0.84***	0.09
Fridays	−0.61***	0.16	−0.50***	0.16	−0.42***	0.11	−0.57***	0.11	−0.49***	0.09
Saturdays	−1.70***	0.22	−1.73***	0.23	−1.02***	0.12	−1.31***	0.14	−1.07***	0.11
Sundays	−1.76***	0.21	−1.87***	0.23	−1.31***	0.13	−1.35***	0.13	−1.22***	0.11
Constant	186.79***	17.31	207.55***	19.53	164.62***	10.56	175.08***	11.27	161.86***	8.80
χ^2	127.98		124.05		253.26		256.44		355.51	
Observations	7,985		8,965		11,978		14,664		17,161	

Notes: *, ** and *** indicate that the explanatory variable is significant at the 0.10, 0.05 and 0.01 significance levels, respectively.

Table 5B. Estimation results of Jetstar's fares for secondary routes.

	Dependent variable: ln(*JQfare*)									
	5-minute window		15-minute window		30-minute window		45-minute window		60-minute window	
Explanatory variables	Coefficients	Standard error	Coefficients	Standard error	Coefficients	Standard error	Coefficients	Standard error	Coefficients	Standard error
ln(*NZfare*)	167.60***	14.75	176.44***	16.07	197.36***	15.74	193.47***	13.65	214.35***	15.12
ln ($NZfare^2$)	−14.30***	1.26	−15.11***	1.38	−16.85***	1.34	−16.55***	1.17	−18.33***	1.29
ln(*NZfreq*)	−2.85***	0.37	−2.51***	0.34	−2.82***	0.33	−2.54***	0.28	−2.71***	0.29
ln(*Distance*)	−0.12	0.08	−0.32***	0.09	−0.10	0.07	−0.14**	0.07	−0.06	0.06
ln(*Fuel*)	−0.47	0.51	0.00	0.52	0.70	0.49	−0.01	0.43	−0.01	0.44
JQwithdrawal	−1.77***	0.29	−1.80***	0.30	−1.81***	0.28	−1.88***	0.26	−1.87***	0.26
Holidays	0.12	0.09	0.10	0.10	0.18*	0.09	0.13	0.08	0.13	0.08
AM	−2.00***	0.69	−0.38	0.34	−0.89**	0.33	−0.44*	0.23	−0.92***	0.25
PM	−1.72**	0.69	0.15	0.34	−0.47	0.33	−0.03	0.23	−0.42*	0.24
Tuesdays	−0.02	0.14	−0.13	0.14	−0.01	0.14	−0.01	0.12	−0.03	0.12
Wednesdays	0.05	0.14	0.00	0.15	0.15	0.14	0.07	0.13	0.06	0.13
Thursdays	0.25*	0.14	0.24	0.15	0.54***	0.14	0.44***	0.13	0.41***	0.13
Fridays	1.45***	0.20	1.63***	0.21	2.09***	0.21	2.04***	0.19	2.13***	0.19
Saturdays	0.96***	0.16	0.99***	0.17	1.12***	0.16	1.01***	0.14	1.00***	0.14
Sundays	0.12	0.15	0.04	0.15	0.02	0.14	−0.11	0.13	−0.14	0.13
Constant	−467.71***	41.36	−494.70***	45.28	−559.03***	44.74	−545.58***	38.66	−605.91***	42.89
χ^2	172.04		156.36		200.89		258.09		255.28	
Observations	7,985		8,965		11,978		14,664		17,161	

Notes: *, ** and *** indicate that the explanatory variable is significant at the 0.10, 0.05 and 0.01 significance levels, respectively.

Australia. We further argue that although jet fuel prices are a widely accepted proxy for airline operating costs and route costs, the actual costs involved in operating a particular route of FSCs such as Air New Zealand are also largely dependent on crew costs, airport taxes and ground operations (Tsoukalas, Belobaba, and Swelbar 2008; Scotti and Volta 2018). In particular, Bitzan and Peoples (2016) found that fuel accounted for 24.5% of average LCC costs but only 19% of average FSC costs. Nevertheless, there is evidence that passengers in New Zealand's domestic aviation market do not normally get the immediate benefits from a fall in jet fuel prices, which happened during the study period (see Figure 1), because of a hysteresis in airfares (Wadud 2015).

The fourth important factor that affects airline price reaction, *JQwithdrawal*, is the decision of Jetstar to stop serving several secondary routes at smaller New Zealand airports from 1 December 2019 (Jetstar 2019). Logically, Jetstar is expected to reap more benefits from its remaining trunk route networks where passenger demand is large – note that Jetstar's official reason for its withdrawal was due to insufficient demand for the secondary markets. Therefore, it is not surprising to see the variable *JQwithdrawal* to be statistically significant in all examined departure time-windows. For instance, Jetstar can increase its airfares with the significant positive *JQwithdrawal* for all time-windows (see Table 4B) while Air New Zealand must reduce its prices at trunk routes with the significant negative *JQwithdrawal* for all time-windows (see Table 4A), suggesting an increase in competition power of the LCC. In contrast, Jetstar reduced its airfares on the remaining secondary routes, which also leads to a reduction of Air New Zealand's airfares at those routes, with the significant negative *JQwithdrawal* for both airlines (see Tables 5A and 5B). Nevertheless, the withdrawal of Jetstar on some secondary routes had put some pressure on Air New Zealand to reduce its airfares on both trunk and secondary routes and thus, brings more competitive power for Jetstar.

Lastly, the impacts of other factors such as holidays (*Holidays*), flight departure times (*AM* and *PM*) and departure date (*Tuesday* s, *Wednesday* s, *Thursday* s, *Friday* s, *Saturdays*, and *Sundays*) are slightly different among the routes and time-windows and extremely difficult to interpret each result for Air New Zealand and Jetstar; therefore we mainly focus on the overall results reported in Table 3. Generally, we observe that the holiday effect contributed to an increase in airfares of both Air New Zealand and Jetstar, in line with previous findings in Australia (De Roos, Mills, and Whelan 2010), Hong Kong (Law et al. 2011), Taiwan (Wen and Yeh 2017), and so on. The most expensive airfare for Air New Zealand is for evening flights, while Jetstar's airfares are cheaper with morning flights. This finding may be due to the difference in the targeted customers of the two airlines: Air New Zealand targets business travellers whilst Jetstar focuses on leisure ones. There is evidence that afternoon and evening flights of LCCs are affected by the purchasing/travelling habit of the leisure passengers (Alderighi, Gaggero, and Piga 2015a; van den Bogaard and Lijesen 2019; Avogadro et al. 2021). For departure dates, flights on Mondays and Sundays seem to be cheaper with Air New Zealand while Mondays and Tuesdays' flights with Jetstar are also cheaper than the other days. Those findings are in line with the empirical results of the airline markets in Australia (De Roos, Mills, and Whelan 2010) and the US (Mantin and Koo 2010).

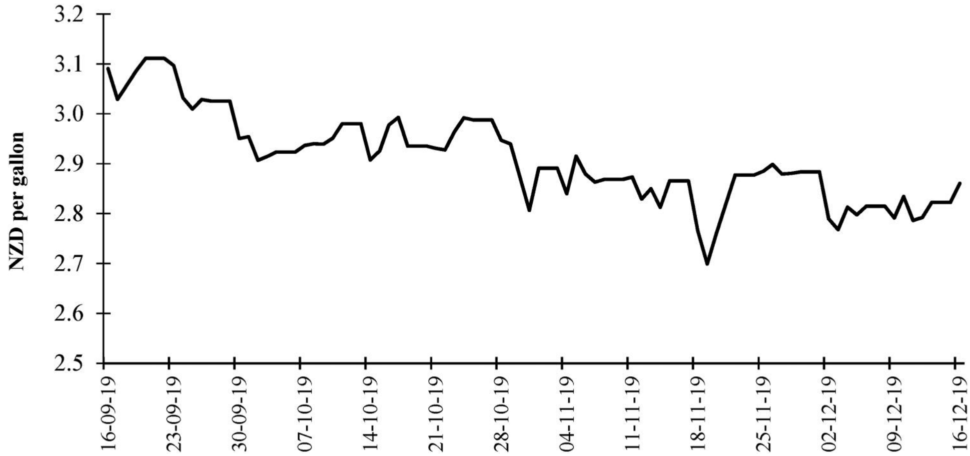

Figure 1. Time plot of jet fuel prices.
This figure shows the fluctuation of jet fuel prices (in NZD) during the examined period with a decreasing trend.

6. Conclusions and future research

This study applies the 3SLS model to empirically investigate the price reaction of two major airlines (Air New Zealand and Jetstar) in New Zealand's duopolistic domestic aviation market for the period of September–December 2019. The price reaction of both airlines is analysed in a simultaneous-equations system regarding their fares for domestic trunk and secondary routes, as well as different departure time windows. Airline competition is dynamic and fierce on both trunk and secondary routes of New Zealand's domestic aviation market. With respect to price reaction and matching, the key findings of this study show that the two airlines generally follow their distinguish business models (i.e. Air New Zealand as a FSC and Jetstar as a LCC), although Air New Zealand exhibits more of a 'low fares' carrier at trunk routes. Accordingly, the airfares are not allowed to be too low for FSCs or too high for LCCs, so that the influence of Jetstar's airfares on Air New Zealand's ticket prices follows an inverted U-shape pattern whilst the impact of Air New Zealand's airfares on Jetstar's follows a U-shape pattern. To be specific, this study finds that when Jetstar's airfares increase, Air New Zealand will decrease its airfares to gain more competitive market power, but it will start to increase airfares later. In contrast, when Air New Zealand increases its airfares, Jetstar will first also increase its airfares but reduce its airfares soon. Such price reaction between two carriers in New Zealand's domestic market, as well as the impacts from other factors such as flight frequency, flying distance, fuel prices, holiday effect, and times and dates of travel, may slightly vary between different types of routes (e.g. trunk routes *vs*. secondary routes) and departure time-windows (e.g. 15-minutes, 30-minutes, or 60-minutes).

These empirical results of this study contribute to the aviation literature. First, this study is the first to explore the intense and competitive duopolistic domestic aviation market in New Zealand. The dominant FSC (Air New Zealand) competes strongly with a smaller LCC competitor (Jetstar) for domestic passenger traffic. Importantly, this suggests the serious challenge posed by the growth and expansion of a foreign-owned LCC (Jetstar is a subsidiary of Qantas) to a national flag carrier (Air New Zealand) under a liberalised trans-Tasman air transport policy (i.e. cabotage) between Australia and New Zealand (Wang et al. 2020). Second, this study also finds that in the context of Jetstar's withdrawal from some secondary markets, it can lead to a 'follow-up' situation at those routes where both Air New Zealand and Jetstar can increase their airfares together, leaving the customers worse-off. On the other hand, such withdrawal may encourage Air New Zealand to be more competitive in the secondary routes, and the customers are better-off, in terms of lower airfares (competition). This withdrawal, however, could still lead to other negative impacts such as air connectivity issue for smaller regions which in turn hinders the economic wellbeing (e.g. tourism) and social wellbeing (e.g. social cohesion, choice of travel and entertainment) of those regions. It is therefore important for New Zealand's regional government and councils to balance such issues.

A few limitations of this study are observed. First, no actual data on passenger bookings or reservations for the examined routes could be collected, which may have limited the application of the more classical supply and demand models (e.g. the Bertrand or Stackelberg model) in this study. However, the current approach in this study used to analyse the price reaction of two major airlines in New Zealand's duopolistic domestic aviation market was largely decided by the availability of airfare data (publicly available). While the model in this study is far from the complicated programme used by airlines to set their ticket prices in reality, due to data availability and the feasibility of accessing those data from airlines, this study still provides a straightforward estimation, which predicts the price of an airline and its reactions in accordance with the prices of its competitor(s). Second, no data were available for other important airline-related factors such as passengers' preference for airline services and frequent flyer programmes (extremely difficult to collect) which can help analyse airline price reaction in this study. As extensions to this study, it may be meaningful to include the actual passenger bookings (when available) and other airline-related factors (e.g. passengers' preference of airline services and frequent flyer programmes) that may further improve our knowledge regarding airline price reaction in New Zealand's duopolistic domestic aviation market. We also acknowledge that the current study does not account for the variable of airfares for different booking periods regarding the departure date (e.g. 14-days or 7-days in advance). However, it is expected that that it would have similar impacts on the two airlines' fares, because airlines should react similarly regardless of the departure-window, and this study therefore can still be promoting further research on other larger markets (such as FSCs *vs.* LCCs, oligopoly and competitive ones) with more complicated settings. In terms of the methodology and modelling, when data is available, it would be interesting to examine different functional forms (e.g. cubic or polynomial) rather than the quadratic one, and using different estimation techniques (e.g. generalized method of moments or full information maximum likelihood) to verify our results.

Notes

1. Data on the total scheduled domestic seat capacity and total scheduled domestic flights of Origin Air have not been captured by the Official Airline Guide (OAG) database.

2. Resende, Amorim, and Valente (2020) examined the airline competition issue in the Brazilian airline sector using a switching cost approach (Shy 2002). Apparently, data limitation in our study does not allow us to apply this approach to the case of New Zealand.
3. The time subscript is omitted in both models in this study for ease of expression. In addition, the logarithmic values of variables are used for estimation, except for the dummy variables.
4. Jetstar is an integral part of the Qantas Group's two-brand strategy but with high levels of independence and autonomy (Wang et al. 2020), therefore, its prices in the New Zealand aviation market are expected to be less likely influenced by Qantas.
5. In New Zealand, Fridays can be seen as the gateway to people's weekends (Arrow 2009) and are believed to have the same weekend effect (Kypri et al. 2014).
6. This study could not treat the collected airfare data as either time series or panel data because the intervals between the observations were not daily or monthly but hourly. For example, 8pm, 9pm (of a certain day), then 7am, 8am (of the following day), and so on. It, therefore, does not allow us to incorporate the lagged prices for estimation, because there may be a relationship between ticket prices at 8pm and 9pm during the same day, but no or a weak relationship exists between ticket prices at 9pm of the previous day and 7am of the following day. Consequently, this study does not use the random-effect or fixed-effect panel models for analysis.
7. We have re-run our models using the dummy variables for the city-pair routes. The new results are consistent with Tables 4-5, which strengthen our findings that airfare competition/reaction of the two airlines differs among the domestic routes. For the sake of brevity, in the Appendix, we only report the main results for all time-windows analysis; other time-window results are available upon proper request.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Data availability statement

The data that support the findings of this study are collected from Ho et al. (2021).

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Appendix: Estimation results for price reaction between Air New Zealand and Jetstar (city-pair routes and all time-windows)

Dependent variable	ln(*NZfare*)		ln(*JQfare*)	
Independent variable	Coefficient	Standard error	Coefficient	Standard error
ln(*NZfare*)			316.88***	20.65
ln ($NZfare^2$)			−27.40***	1.79
ln(*NZfreq*)			−0.13	0.14
ln(*JQfare*)	−108.84***	8.42		
ln ($JQfare^2$)	11.08***	0.86		
ln(*JQfreq*)	0.56***	0.08		
ln(*Distance*)	38.97***	2.95	−136.92***	8.96
ln(*Fuel*)	4.70***	0.45	−0.65*	0.38
JQwithdrawal	0.20**	0.08	−0.51***	0.14
Holidays	0.31***	0.05	0.35***	0.08
AM	0.08	0.09	−0.69***	0.16
PM	−0.36***	0.10	0.24	0.16
Tuesdays	0.52***	0.08	0.09	0.11
Wednesdays	1.10***	0.10	−0.10	0.11
Thursdays	0.43***	0.07	0.83***	0.11
Fridays	0.59***	0.08	1.99***	0.15
Saturdays	0.34***	0.07	1.51***	0.14
Sundays	−0.12*	0.07	0.40***	0.11
City-pair routes dummies	Yes		Yes	
χ^2	10901.45		2787.69	
Observations	53,463		53,463	

Notes: *, ** and *** indicate that the explanatory variable is significant at the 0.10, 0.05 and 0.01 significance levels, respectively.