

Chapter 3

Short- and Long-Term Reaction to Exogenous Demand Shifts¹

*Although this may seem a paradox,
all exact science is dominated by the idea of approximation.*

Bertrand Russell

3.1 Introduction

In less than 10 years, the liberalization of the European airline industry has placed flag carriers in a highly competitive and dynamic environment. One of the reasons for the demand dynamic clearly results from the peculiarity of the industry: airline carriers have to produce one of the most perishable goods (passenger transport). This fact has forced carriers to implement and refine practices and strategies in order to react promptly to the ups and downs of the demand. In Chap. 2 we described the common practices employed to face short-term demand fluctuations that usually rely on advanced pricing policies, called ‘yield management’. Long-lasting demand shifts require a reaction in terms of capacity supply described in Sect. 2.4.2 as ‘network planning’.

In this chapter, we focus on this second aspect. Exploring the behaviour of carriers in such a complex context seems to be very difficult unless it is based on particular situations as important demand shifts. Recently, two terrible events have characterized the world economy: the September 11 terrorist attack on the Twin Towers in New York and on the Pentagon in Washington in 2001, and the SARS epidemic in East Asia which began in February 2003. These events have produced two dramatic crises especially in, respectively, the North American and the Asian market. By analysing these two important demand shifts, we are able to detect some determinants in order to analyse the carriers’ conduct. In particular, we have split the carriers’ conduct into short- and long-term determinants to capture information

¹ An earlier version of this chapter together with Chap. 4 appeared as a joint article (Alderighi et al. 2004) in the *Journal of Air Transport Management* 10: 97–107, 2004.

about the carrier's strategies (internal policy, expectations for the evolution of the markets, etc.) and its specific characteristics (structure of the network, adjustment costs, financial situation). To be comprehensive, an analysis based on short- and long-term components needs to be both theoretical and empirical. From a theoretical point of view, we show that, if capacity variations are costly, it is optimal to base a capacity reaction on both short- and long-term profitability where the right mix depends upon the importance and duration of the shock. From an empirical point of view, we can explain the carrier's capacity choices with two variables: the passenger reduction due to the shock, and the expected profitability of the market.

To clarify the first point, suppose that an unexpected shock reduces demand. A carrier can react by decreasing its offer but incurring a cost of adjustment. If the shock is brief, the carrier's choice during the crisis period is mainly based on the expected situation after the crisis. In fact, its reaction aims to limit the costs of reducing and restating the capacity. On the contrary, when there is a long-lasting shock, the carrier focuses on the crisis period, as post-crisis profits are far away and their discounted value is low. Adjustment costs also induce carriers to behave strategically. In fact, a carrier that increases (or decreases less) the capacity during the crisis period forces its competitor to reduce its capacity offer in the post-crisis period. This phenomenon is known in the literature as 'pre-emption'. Pre-emption reduces the reactivity of the carrier to the shock during the crisis.

Theoretical results are based on the assumption that carriers encounter adjustment costs in changing the network configuration, so that their choice depends on short- and long-term variables. Any modification of the flight supply involves costs. For instance, a carrier that decides to enter a new route needs to have new rights at the airport (slot), organize new staff, promote and advertise the new route, launch price actions, and so on. Moreover, in the short term, the aircraft for the new route has to be moved from another route to the new one, and the logistic activity has to be adjusted to the new aircraft rotations. Finally, reducing frequencies or closing a route is a costly decision seeing that a carrier needs to change the aircraft rotations or definitely ground a plane. It is worth noting that adjustment costs are first of all set-up costs and hence are higher when carriers want to enter or expand a route than when they want to exit from or reduce it.

We assume that adjustment costs are usually high for large carriers (carriers with higher market shares), since they employ local ground staff, but are low for small carriers that usually outsource ground activities. In addition, closing and opening an intercontinental route implies a re-optimization of the network, which is more complex and costly for larger carriers. Other factors such as specific network characteristics and the flexibility of the fleet, i.e. the number of aircraft that can operate both on short- and long-haul routes, can have an impact on the importance of the adjustment costs. The existence of adjustment costs motivates the decision to change the capacity supply only few times a year and in the meantime to compete in prices.

In Chap. 2 we presented the network management as the process to develop and control the network. This process is usually organized in terms of four levels: (1) *network strategy*, (2) *network design*, (3) *alliances*, (4) *network planning*. Crises

such as September 11 or the SARS epidemic have affected the network planning of the European carriers. This chapter and the next one are dedicated to analysing how the network strategy and planning have functioned to react to the global crises.

Specifically, we present a dynamic game-theoretical framework organized in three stages, which are a time-continuous sequence of periods. In each period, carriers take operational actions (i.e. they choose a price); in each stage, they choose their tactics (corresponding to a capacity offer); and, in the entire game, they follow a strategic plan (i.e. the choice of a strategy to solve the overall game). The empirical model presented in Chap. 4 does not consider operational decisions but focuses on tactical and strategic plans that are driven by short- and long-term indicators, respectively.

Recently, the literature has reported new research in the field of the airline crisis. In particular, Hätyy and Hollmeier (2003), Alderighi and Cento (2005) present a view of the airline crisis after the September 11 and SARS epidemic. Their first contributions are strongly related to this chapter, being divided into two parts, one dealing with the theoretical framework and the other with the results of the North American crisis. Their second contribution originates from the internal debate in the crisis management unit at Lufthansa Airlines. In that study, it is shown that the reduction of air traffic demand is matched by industry capacity reduction. When demand declines, capacity can not be adjusted immediately because of the insufficient flexibility. These authors conclude that managing the crisis aims not only to restore the pre-crisis state but rather to form a more healthy business environment. In addition, Gillen and Lall (2003) examine shock transmission in the airline industry after September 11. Their research attempts to identify three main propagation channels: the trade effect; the alliance effect; and the wake-up call effect.

The remainder of this chapter is organized as follows: Sect. 3.2 presents a brief description of the airline sector during the North American and Asian crises. In Sect. 3.3 we provide the theoretical model. The results and conclusion are presented in Sects. 3.4 and 3.5. This chapter represents the theoretical basis for the empirical analysis presented in Chap. 4.

3.2 Exogenous Demand Shifts: The American and Asian Crises

The September 11 terrorist attack on United States and the SARS epidemic in Asia had a strong impact throughout the airline sector. The North America crisis has been the most tragic shock that the industry has faced in its recent history. The SARS shock strongly hampered the carriers' expectation for the development of the Asian market. In the next two subsections we provide some facts and figures that describe the shocks and the subsequent reactions of the European carriers. The description is necessary to support some of the methodological decisions that have been taken in the econometric analysis.

3.2.1 *The September 11 Terrorist Attack*

On 11 September 2001, one Boeing of American Airlines and one of United Airlines were diverted by terrorists to crash on the Twin Towers in New York City, and a third Boeing of America Airlines was diverted to crash on the Pentagon in Washington. For security reasons the North American air space was closed for the next five days. Eight days after the terrorist attack the Lufthansa Chief Executive Officer Jurgen Weber, made the following statement on 19 September 2001:

...the losses incurred due to the closure of US and Canadian airspace, flight diversions, cancellations and drop in demand have made it necessary for companies to revise their profit forecast and capacity supply. The forecasting was dependent on an economy upswing in the last quarter of the year, which was no longer anticipated in the wake of the 11th September event. The aviation industry has been hit badly by the consequences of the terrorist attacks. It will require immense efforts on the part of Lufthansa staff if we are to avoid an operating loss this year. (www.lufthansa.com).

The revenue passenger kilometres (RPK)² and the available seat kilometres (ASK)³ are two relevant market indicators to understand the impact of the crisis on the airline industries. The indicators refer to the transatlantic traffic generated by European carriers to North Atlantic destinations; they are seasonally adjusted and observed as a year-to-year index.

Before the terrorist attacks, the RPK between Europe and North America had a zero growth, afterwards RPK dropped significantly in October (−26 percent) and reached its lowest point in November (−33 percent). The European carriers' reacted to adjust their capacity in November (−15 percent). Afterwards the capacity reduction continued until January 2002, when it reached the lowest point of the crisis (−26 percent).

The indicators are plotted in Fig. 3.1. The two series are clearly affected by a strong downturn, in October for the RPK, and in November for ASK. The market had fully recovered from the crisis in terms of RPK in February 2003, and in terms of ASK in March 2003. In general, carriers reduced their capacity supply by cutting the frequencies and the aircraft size, or closing routes. For example, KLM adjusted its flights to the US by reducing weekly frequencies to New York (from 13 to 11), to San Francisco (from 7 to 6), to Miami (from 7 to 5), and to Detroit (from 4 to 3). It also closed the Amsterdam-Atlanta route, and reduced the aircraft size to Canada (Montreal: from Boeing 747 to Boeing 767; Toronto: from Boeing 747 to McDon Douglas 11). Table 3.1 presents the capacity reduction per carrier (ASK) as a year-to-year index. The index decreases to under 100⁴ in the last quarter of 2001 (Oct–Dec) immediately after the September demand shift. Some carriers such

² The RPK is the number of passengers who generated revenue (free travelers are excluded) normalized by the length of the journey in kilometres.

³ The ASK is the number of seats offered by the carriers on a certain route multiplied the route length (in kilometres).

⁴ The index is calculated as the current year value divided by previous year value and multiplied by 100. When the index is equal to 100, the current value is equal to the previous year value, when is lower than 100 it means that the current value is lower than the previous year value.

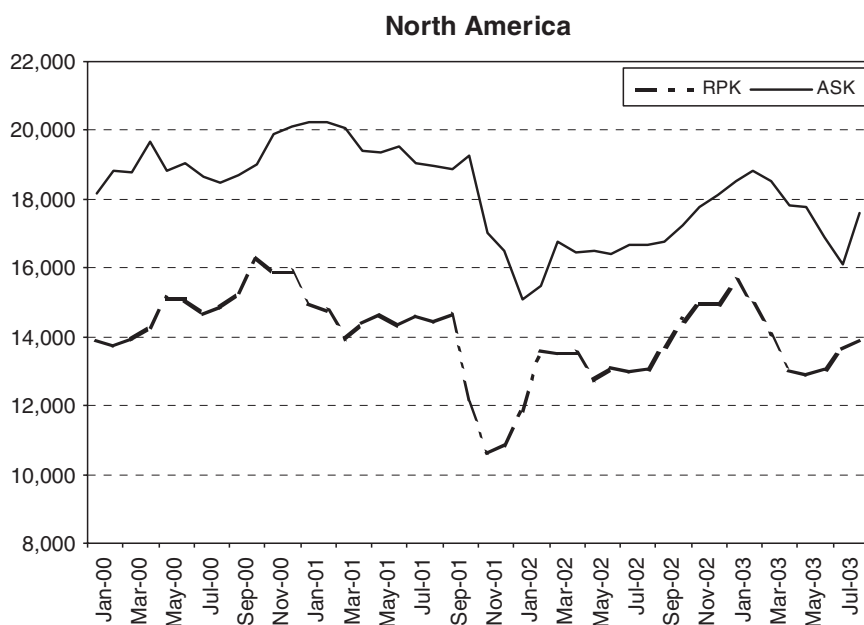


Fig. 3.1 The revenue passenger kilometres (RPKs) and the available seat kilometres (ASKs) development for the traffic flows from Europe to North America (Source: AEA seasonally adjusted)

Table 3.1 ASK (index versus previous year) for traffic flows from Europe to North America per carrier

| Carrier | Jan–Mar 2001 | Apr–Jun 2001 | Jul–Sep 2001 | Oct–Dec 2001 | Jan–Mar 2002 | Apr–Jun 2002 | Jul–Sep 2002 |
|-------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Air France | 115 | 116 | 103 | 87 | 81 | 85 | 95 |
| Alitalia | 106 | 93 | 89 | 70 | 61 | 52 | 55 |
| British A. | 96 | 85 | 83 | 79 | 87 | 96 | 99 |
| Aer Lingus | 106 | 119 | 106 | 89 | – | – | – |
| Iberia | 102 | 106 | 95 | 84 | 81 | 83 | 106 |
| KLM | 90 | 99 | 93 | 72 | 77 | 66 | 77 |
| Lufthansa | 112 | 109 | 104 | 83 | 78 | 86 | 95 |
| Swiss | 104 | 109 | 95 | 61 | 62 | 60 | 63 |
| Austrian A. | 137 | 142 | 136 | 80 | 62 | 45 | 47 |
| SAS | 101 | 107 | 112 | 96 | 97 | 105 | 109 |
| Total | 103 | 101 | 95 | 79 | 76 | 78 | 84 |

Source: AEA

as British Airways, Alitalia or KLM seemed to reduce their capacity already in September 2001 as the index fell lower than 100. Nevertheless, these indices presented the same negative growth even before the crisis. These carriers were already in a capacity reduction process regardless of the forthcoming crisis. On the contrary, other carriers such as Air France, Aer Lingus and SAS were above 100 in the third

quarter since they registered a positive trend before the crisis. In this perspective, the indices cannot be compared among the carriers but only as trend over time. In the last quarter of 2001, the carriers reduced their capacity offer, and the cut ranged from -39 percent of Swiss⁵ to -4 percent of SAS.

3.2.2 *The SARS Epidemic*

The severe acute respiratory syndrome (SARS) is a respiratory illness caused by a virus. SARS was first reported in Asia in February 2003. Over the next few months, the illness spread to more than two-dozen countries in North America, South America, Europe, and Asia. According to the World Health Organization, during the SARS outbreak of 2003, a total of 8,098 people worldwide became sick with SARS; and, of these, 774 died. Most of the SARS cases in Europe were among travellers returning from other parts of the world, particularly from Asia. As the main way that SARS appears to spread is by close person-to-person contact, fears of contagion and the official travel advice to defer non-essential travel generated a shock in the demand, mainly for air transport to Asia and Canada.

Before the epidemic spread, the RPK from Europe to Asia was still recovering from previous crises (September 11, the Afghanistan war, and the October 2002 Bali terrorist attack) and showed positive growth. After these crises, the negative trend was again evident in March (-8 percent), just one month after the first SARS case was reported. During the succeeding months, the demand sank (-22 percent in the April RPK), and reached its lowest point in May 2003 (-30 percent). The European carriers reaction is captured by the ASK index. The capacity adjustment started two months later in May 2003 (-15 percent) and continued in the next two months (June 2003 -15 percent, July -8 percent).

The two indicators are plotted in Fig. 3.2. The time path is clearly affected by the two big crises, i.e. September 11 and SARS. Both negative shocks can be detected in the plotted time series; nevertheless, the effects were different in terms of both magnitude and the recovery path to the pre-crisis situations. Due to the September 11 attack, the RPK decreased to the lowest value of 7,499, while the lowest point reached in the SARS crisis was even lower (6,403). In the first crisis, the downturn of the RPK came in October 2001. A minor shift was registered in December 2002 due to the announcement of the Iraqi war, which generated negative expectations of travel security and economic development in the Asian areas. In the second crisis, the drop was in March 2003 and became strong in April 2003.

The carrier's reaction is presented in Table 3.2 in terms of the ASK year-to-year index. In August 2003, the crisis did not seem to be completely absorbed by the market. Over the first quarter of 2003 (Jan–Mar), the carriers considered were still enjoying a phase of expansion, the only exception being British Airways which

⁵ The name 'Swiss', as opposed to 'Swiss Air', has been adopted throughout this chapter, as Swiss Air went bankrupt after the September 11 crisis, after which a new airline with the name Swiss was created.

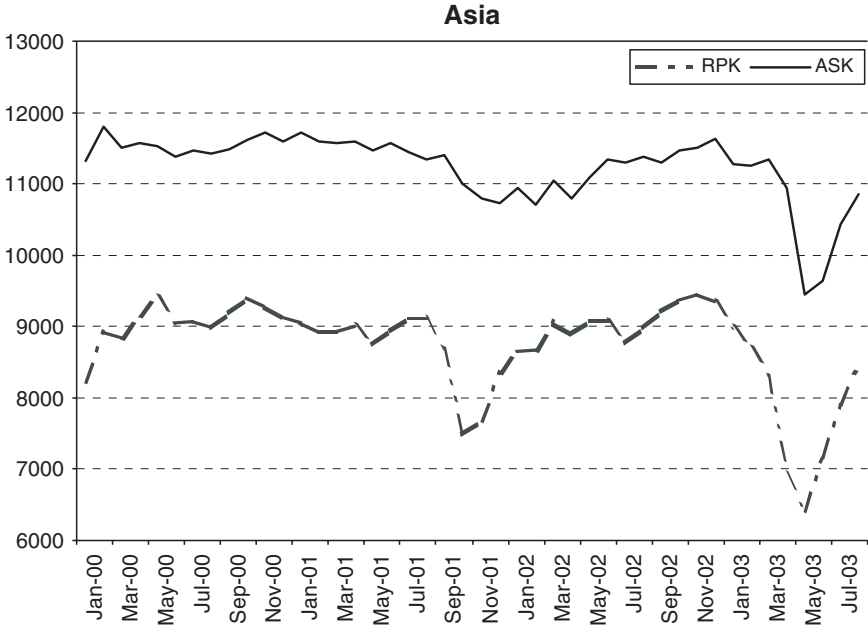


Fig. 3.2 The revenue passenger kilometres (RPKs) and the available seat kilometres (ASKs) development for traffic flows from Europe to Asia (Source: AEA seasonally adjusted)

Table 3.2 ASK (index versus previous year) for traffic flows from Europe to Asia

| | Apr–Jun 2002 | Jul–Sep 2002 | Oct–Dec 2002 | Jan–Mar 2003 | Apr–Jun 2003 | Jul 2003 | Aug 2003 |
|-------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-------------|-------------|
| Air France | 105 | 104 | 107 | 103 | 83 | 82 | 85 |
| Alitalia | 74 | 85 | 101 | 131 | 120 | 105 | 107 |
| British Airways | 81 | 87 | 86 | 85 | 92 | 105 | 105 |
| KLM | 95 | 99 | 100 | 107 | 92 | 94 | 102 |
| Lufthansa | 101 | 102 | 106 | 108 | 86 | 88 | 92 |
| Swiss | 69 | 69 | 99 | 106 | 82 | 79 | 83 |
| Austrian Airlines | 110 | 125 | 136 | 137 | 100 | 97 | 101 |
| SAS | 120 | 114 | 110 | 112 | 85 | 75 | 73 |
| Total | 93 | 96 | 102 | 104 | 91 | 92 | 95 |

Source: AEA

was stable for almost all 2002 with an index of 81–87. In the second quarter of 2003 (Apr–Jun), ASK fell drastically for every carrier, with different magnitudes, ranging from 18 percent for Swiss to 8 percent for KLM and British Airways.

Similarly to the previous crisis, European carriers reduced their capacity in term of frequencies, aircraft size and routes. Additionally, airlines also adjusted their capacity by introducing triangular services. The Asian routes are on average 3,000 km longer than the North American ones and passengers are willing to tolerate a stop service in order to keep the same number of frequencies. Triangular flights

are one way for a carrier to introduce a temporary modification of capacity supply, as reported in a KLM press release:

... the capacity adjustments particularly on routes to Asia and North America are made in response to declining demand resulting from developments surrounding the SARS virus. All schedule adjustments are temporary... (www.klm.com).

The Dutch airline reduced their capacity by cutting the frequency on the routes: Amsterdam–Shanghai (from 5 to 4 weekly roundtrips),⁶ Amsterdam–Beijing (from 4 to 2 weekly circle trips via Shanghai); Amsterdam–Hong Kong (from 7 to 4 weekly round trips) and Amsterdam–Singapore–Jakarta (from 7 to 5 weekly round trips).

Comparing the SARS crisis in Asia to that of September 11 in North America, we observe that the crises are similar in terms of shock magnitude but different in terms of time duration. Both recorded a demand reduction equal approximately to 30–36 percent, and while the September 11 crisis lasted for 17 months, that of SARS was only 6–7 months long. In terms of capacity reduction, the carriers also reacted similarly to both shocks. Nevertheless, the reaction to September 11 was drastic but delayed by two months, while the reaction to SARS seems quicker and limited (–15 percent capacity reduction versus an RPK reduction of 30 percent). The questions that arise are: How do the carriers react to crisis situations and how can this be modelled in order to explain their general behaviour?

3.3 Theoretical Model

We consider a duopolistic market⁷ consisting of two firms: namely, *A* and *B*. They compete in quantities (capacities), and we assume that firms revise their capacity supply only rarely since, in modifying their flight supply, they incur adjustment costs.

The model is set in a continuous time framework, and firms are profit maximizers. To keep things simple, we assume that at date 0 there is an unpredicted negative shock (that is described as a temporary reduction of the demand), and that firms modify their capacity supply only twice: once when the shock has occurred and again when it ends. When managing the crises, the firms do not have interactive behaviour with the competitors as they focus mainly on their survivability. In what follows, we present a simplified version where we assume that the duration of the crisis is known just after the shock has occurred. At the end of the section, we informally present some extensions which do not substantially change the main results of the model. Therefore, we start by assuming no uncertainty regarding the duration

⁶ A round trip flies there and back on the same route. A circle trip flies from the origin on the outward journey, stopping at one or more places on route, but it flies straight back from the final destination without stopping en route.

⁷ In this model, we focus on a single market that corresponds to a single intercontinental route.

of the crisis, no financial constraints, and no differences in the adjustment costs. The timing of the game is as follows:

- (Stage 0) Before time 0, the market is in long-term equilibrium. That means the capacity that firms A and B have chosen is the solution of a Cournot game.⁸ The outcome of this stage-game is J_0 , K_0 and p_0 , where J_0 and K_0 are, respectively, the capacity choice of firm A and B at Stage 0, and p_0 is the equilibrium price at Stage 0.
- *Stage 1*: At time 0, there is an unpredicted (negative) shock in the demand with a certain duration $\theta > 0$. Firms change their capacity.⁹ The outcome is J_1 , K_1 and p_1 .
- *Stage 2*: At time θ , the negative shock ends. Firms modify their capacities with a cost that increases with the capacity change.¹⁰ In this case, the outcome is J_2 , K_2 and p_2 .

We solve the model backwards, starting from Stage 2, and then we move to Stage 1. We will only focus on the behaviour of firm A, since there is an analogous solution for firm B. The overall profit of firm A can be described as the sum of the discounted instantaneous profits. We call π_1^A and π_2^A the instantaneous profit of firm A at Stage 1 and 2, respectively.¹¹ The overall profit for firm A, namely Π^A , is:

$$\Pi^A = \int_0^\theta e^{-rt} \pi_1^A dt + \int_\theta^\infty e^{-rt} \pi_2^A dt = r^{-1} (1 - e^{-r\theta}) \pi_1^A + r^{-1} e^{-r\theta} \pi_2^A, \quad (3.1)$$

where r is the interest rate, and e^{-rt} is the discount factor.

The Stage 2 equilibrium is computed assuming that firms have already chosen their capacity in the first stage. The inverse demand in the second Stage 2 is $p_2 = a - Q_2$, where Q_2 is the quantity supplied by both firms. During the crisis period $(0, \theta)$, the demand was $p_1 = b - Q_1$ with $0 < b < a$. At time $t \in [\theta, \infty)$, firms A and B maximize their profit, given J_1 and K_1 , where J_1 and K_1 are, respectively, the capacity choice of firm A and that of firm B in Stage 1. At time $t = \theta$, they choose the capacity J_2 and K_2 to maximize their profits.

In the Stage 2, the period profit of firm A is:

$$\pi_2^A = (b - c - J_2 - K_2)J_2 - D(J_1, J_2, \delta), \quad (3.2)$$

where c is the unit-cost for the installed capacity and $D(J_1, J_2, \delta) = (J_2 - J_1)^2$ are the (per-period) adjustment costs.¹² We define $J_2^* = J_2^*(J_1, K_1)$, the optimal capacity

⁸ Because no costs of adjustment are assumed in Stage 1, the equilibrium levels before time 0 do not have an impact on the choices in Stage 1 and 2, but we maintain this assumption because it is necessary to consistently compute the capacity change.

⁹ For simplicity, in Stage 1, the capacity adjustment is costless.

¹⁰ See, e. g., Gould (1968).

¹¹ Because firms can not change their capacity supply during these stages, their per period profit is constant.

¹² For technical reasons, we assume that the adjustment costs are persistent, i.e. they span the interval $[\theta, \infty)$. Similar results can be obtained under the assumption that these costs are only realized at time θ .

level in the second Stage 2, as a function of J_1 and K_1 . Hence, after some computations, the solution of Stage 2 of the game is:

$$J_2^*(J_1, K_1) = \frac{(1 + 2\delta)(a - c) + 4\delta(1 + \delta)J_1 - 2\delta K_1}{4(1 + \delta)^2 - 1}. \quad (3.3)$$

Note that the optimal level J_2^* is affected by the costs of adjustment and by the decisions taken in Stage 1: namely, J_1 and K_1 . The Stage 1 instantaneous profit of firm A is given by:

$$\pi_1^A = (b - c - J_1 - K_1)J_1. \quad (3.4)$$

The firms' behaviour in the Stage 1 is determined by the optimization of the overall profit described by Eq. 3.1. For firm A, this is equivalent to the maximization of the following equation:

$$\max_{J_1} R\pi_1^A(J_1, K_1) + \pi_2^A(J_2^*, K_2^*, D), \quad (3.5)$$

where $R = (1 - e^{-r\theta})/e^{-r\theta}$ is the expected duration of the crisis,¹³ $J_2^* = J_2^*(J_1, K_1)$ and $K_2^* = K_2^*(J_1, K_1)$ are the optimal capacity levels of A and B, respectively, in Stage 2, and D are the adjustment costs of A. The solution of this optimization problem is the reaction function of firm A in Stage 1.

The first-order condition implies that:

$$re^{r\theta} \frac{d\Pi^A}{dJ_1} = R \frac{d\pi_1^A}{dJ_1} + \frac{d\pi_2^A}{dJ_1} = 0. \quad (3.6)$$

When firm A maximizes the overall profit it balances its choice between the short-term effect and long-term effect. The short-term effect is the traditional result of the duopoly theory: $d\pi_1^A/dJ_1 = (b - c - 2J_1 - K_1)$, while the long-term effect

$$\frac{d\pi_2^A}{dJ_1} = \frac{\partial \pi_2^A}{\partial J_1} + \frac{\partial \pi_2^A}{\partial J_2} \frac{\partial J_2^*}{\partial J_1} + \frac{\partial \pi_2^A}{\partial K_2} \frac{\partial K_2^*}{\partial J_1} + \frac{\partial \pi_2^A}{\partial D} \frac{\partial D}{\partial J_1} \quad (3.7)$$

is composed of 4 different impacts. The first and second terms of the RHS of Eq. 3.7 are null, because J_1 does not directly affect π_2^A , and because of the envelope theorem: $\partial \pi_2^A / \partial J_2 = 0$. The third term captures the strategic effect and corresponds to the impact of J_1 on π_2^A due to a change in K_2^* :

$$\frac{\partial \pi_2^A}{\partial K_2} \frac{\partial K_2^*}{\partial J_1} = J_2^* \frac{2\delta}{4(1 + \delta)^2 - 1}.$$

The sign of the strategic effect is always positive because Stage 2 actions are strategic substitutes (i.e. the reaction curves are downward sloping¹⁴). In fact, through increasing the capacity in Stage 1, a firm forces its competitor to reduce its capacity

¹³ The function R should not be confused with the parameter θ , which is the real duration of the crisis and it is unknown to the carrier. The function R is the duration of the crisis that the carrier expects.

¹⁴ See Fudenberg and Tirole 1984, and Bulow et al. (1993).

in Stage 2. In the literature, this effect is called ‘pre-emption’. In the limit case (when $\delta = 0$), the strategic effect is not present.

The fourth term corresponds to the impact of J_1 on π_2^A due to a change in D :

$$\frac{\partial \pi_2^A}{\partial D} \frac{\partial D}{\partial J_1} = 2\delta(J_2^* - J_1),$$

and is positive as soon as $J_2^* - J_1 > 0$. It captures the resistance of a firm in reducing its capacity in Stage 1 since it has to bear high costs in Stage 2 for increasing the capacity. Also this term is null when $\delta = 0$.

The presence of adjustment costs complicates the optimization problem. In fact, the equilibrium solution in the Stage 1 is characterized by strategic considerations as well as cost considerations regarding the choice of Stage 2. The optimization problem is clearly simplified when $\delta = 0$, where the equilibrium solutions are the usual ones of a static duopolistic game: $J_1^* = J_b = (b - c)/3$ and $J_2^* = J_a = (a - c)/3$. In the general case, when $\delta > 0$, the optimal solution J_1^* is given by:

$$J_1^* = \frac{1}{3} \frac{R(1 + 2\delta)(2\delta + 3)^2(b - c) + 8\delta(1 + \delta)^2(a - c)}{R(1 + 2\delta)(2\delta + 3)^2 + 8\delta(1 + \delta)^2 - \frac{2}{3}\delta(2\delta + 3)}, \quad (3.8)$$

Rearranging the previous equation, we have:

$$J_1^* = (1 + o)(\lambda J_b + (1 - \lambda)J_a), \quad (3.9)$$

where

$$\lambda = \frac{R(1 + 2\delta)(2\delta + 3)^2}{R(1 + 2\delta)(2\delta + 3)^2 + 8\delta(1 + \delta)^2}, \quad (3.10)$$

and

$$o = \frac{\frac{2}{3}(2\delta + 3)}{R(1 + 2\delta)(2\delta + 3)^2 + 8\delta(1 + \delta)^2 - \frac{2}{3}(2\delta + 3)}. \quad (3.11)$$

In order to simplify the discussion of Eq. 3.9, we will focus on the second part of the equation.¹⁵ The second bracket indicates that the solution is a combination of the long-term solution and the short-term solution of the static game. The weights λ and $(1 - \lambda)$ depend on δ (the adjustment costs) and R (the duration of the crisis). Different values of these parameters modify the weights of the short- and long-term solution of the static problem. If λ is close to 0 (R low or δ high), the solution J_1^* is close to J_a , i.e. the long-term solution; on the other hand, if λ is close to 1, the solution J_1^* is close to J_b , i.e. the short-term solution.

Hereafter, we investigate the relationship between long-term and short-term profitability and the variation of the capacity supply.

¹⁵ The first bracket is greater than 1 when $\delta > 0$, but is approximately 1 whenever R is not too small, so that we can neglect it from our discussion. In fact, $o < 0.01$ when $R > 0.6$ for every value of δ , and $o < 0.1$ when $R > 0.2$.

We define $\Delta S = J_1^* - J_0^*$ as the variation of the capacity supply, $\Delta P = (b - a)$ the fall in the short-term profitability, and $Y = (a - c)$ the long-term profitability. Using Eq. 3.8, after some computations, we have:

$$\Delta S = \frac{1}{3} \frac{R(1+2\delta)(2\delta+3)^2 \Delta P + 8\delta(1+\delta)^2 Y}{R(1+2\delta)(2\delta+3)^2 + 8\delta(1+\delta)^2 - \frac{2}{3}(2\delta+3)}. \quad (3.12)$$

We define α_S and α_L as the reactivity of the capacity variation to a change of the short- and long-term indicator, respectively. They are defined as follows:

$$\alpha_S = \frac{\partial(\Delta S)}{\partial(\Delta P)} = \frac{1}{3} \frac{R(1+2\delta)(2\delta+3)^2}{R(1+2\delta)(2\delta+3)^2 + 8\delta(1+\delta)^2 - \frac{2}{3}\delta(2\delta+3)} \quad (3.13)$$

and

$$\alpha_L = \frac{\partial(\Delta S)}{\partial Y} = \frac{1}{3} \frac{8\delta(1+\delta)^2}{R(1+2\delta)(2\delta+3)^2 + 8\delta(1+\delta)^2 - \frac{2}{3}\delta(2\delta+3)}. \quad (3.14)$$

Hence, replacing α_S and α_L in Eq. 3.12, we have:

$$\Delta S = \alpha_S \Delta P + \alpha_L Y. \quad (3.15)$$

Equation 3.15 shows that the capacity reduction (or expansion) is a mixture of short- and long-term profitability,¹⁶ and Eqs. 3.13 and 3.14 indicate that α_S and α_L depend on δ and R .

A change of the adjustment costs and of the duration of the crisis modifies the composition of the optimal reaction of the firms.

The ratio

$$\frac{\alpha_S}{\alpha_L} = \frac{1}{8} \frac{R(1+2\delta)(2\delta+3)^2}{\delta(1+\delta)^2}$$

provides some indications of the firm's responsiveness to a change in the adjustment costs. It is simple to verify that the ratio is decreasing in δ , meaning that an increase in the adjustment costs shifts the attention from the short-term to the long-term goals. Therefore, firms care more about the future situation since higher adjustment costs imply more pre-emption and more expenditure to adjust to the long-term equilibrium.

The ratio α_S/α_L can also be used in order to analyse the impact of the duration of the crisis on the strategy composition. When the duration is short, α_S/α_L is large, while when the duration is long, α_S/α_L is small. This point has a very simple interpretation. If the shock is long, each firm will focus on the crisis period by reacting to the demand reduction. If the shock is short, the decision can be based on the

¹⁶ In Chap. 4, we will base our empirical analysis on Eq. 3.15. In Sect. 3.4, Fig. 3.3, we will provide a graphical representation of α_S and α_L as a function of R and δ . Note that the model we propose fits for the duopolistic case, but in the empirical part there are situations including different market structures, e.g. in the North American case there are some routes with more than two carriers. As qualitative results do not change, we assume that the model holds in any situation.

post-crisis perspective, and hence on the long-term market profitability. Therefore, when the duration is short the capacity reaction is driven by long-term profitability, while if the duration is long, the capacity reaction depends on short-term profitability. Analogously, an increase of the interest rate r affects the α_S/α_L ratio positively.

Finally, we have to stress that as δ increases the carriers are less flexible. When carriers have low adjustment costs, they react strongly to a shock, and when they have high adjustment costs they react weakly. We will clarify¹⁷ this argument in Sect. 3.4.

In what follows, we present the main conclusions of the previous analysis in an informal way. We focus on four different situations: (1) when there is uncertainty about the crisis duration; (2) when carriers have different discount factors; (3) when firms have different adjustment costs; and (4) when firm B has a financial constraint. In these cases, we also observe different combinations of the short- and long-term indicators for the determination of the equilibrium choice.

First, we consider the case where the two firms have uncertainty about the duration of the crisis.¹⁸ Each firm can base its predictions on its private information (for example, the result founded by the research team and by the task-force created to tackle the crisis). Each firm formulates its expectations independently from the other and chooses a capacity level. We assume that there are only two possible states of nature with known probabilities: $\theta = \{\theta_L, \theta_S\}$, where $\theta_L > \theta_S$.¹⁹ We assume that each firm does not have knowledge of the opponent's expectations and bases its choice on its own information. If the firm expects $\theta = \theta_L$, it will focus more on the short-term aspects, and hence α_L is low and α_S is large. If the firm expects $\theta = \theta_S$, it will be the opposite: α_S is low and α_L large.

Second, firms may have different discount factors, for example $r_A > r_B$. This situation occurs when carrier A values its future profits more (and hence is more interested in being on the market in future) than carrier B. Clearly, carrier A will focus more on the long-term aspects and less on the short-term aspects than carrier B.

Third, we consider the case where firms have different adjustment costs, for example $\delta_A > \delta_B$. In this situation, firm A will be more reactive to the long-term, while firm B will be more reactive to the short-term.

Finally, we now assume that firm B cannot choose to react as before, since it has a financial constraint (that may depend on low liquidity or high pressure from

¹⁷ A formal interpretation of flexibility is as follows. Let $J^*(\delta, R)$ be the capacity when the adjustment costs are δ and the length of the crisis is R . For any δ and δ' such that $\delta' < \delta$, and for every $R \in (0, \infty)$, there is an $R' \in (0, \infty)$ such that

$$(a) \frac{d}{d\alpha} J^*(\delta, R) < \frac{d}{d\alpha} J^*(\delta', R')$$

and

$$(b) \frac{d}{db} J^*(\delta, R) < \frac{d}{db} J^*(\delta', R').$$

Moreover, under the same conditions, there is no R' such that both the inequalities hold if $\delta' > \delta$.

¹⁸ See also Bashyam (1996).

¹⁹ Where L stands for 'long' duration, and S for 'short' duration.

investors, high debts, and so on). In particular, firm *B* can find it difficult, all things being equal, to maintain high K_1^* in conditions of low short-term profitability, even if long-term profitability is high. Therefore, firm *B* is characterized by low reaction to long-term indicators and strong reaction to short-term indicators, which means high values of α_S and low values of α_L .

3.4 Results

The main outcomes of the theoretical model can be simulated by means of a three-dimensional scatter plot (Fig. 3.3). The sensitivity of the carriers to short- and long-term profitability is displayed, respectively, on the X and Y axis (base of plot). A point located in the upper-left side identifies a carrier with long-term goals. On the other hand, a point plotted in the lower-right side identifies a carrier which pursues short-term goals. Carriers plotted in the middle adopt a mixed conduct.

The graph shows three different curves, each one referring to a different level of expected duration of the crisis duration (or different interest rates²⁰). The first line on the left side indicates a carrier with an expectation of a long crisis; the second line represents a carrier with an expectation of the medium-length crisis, and the

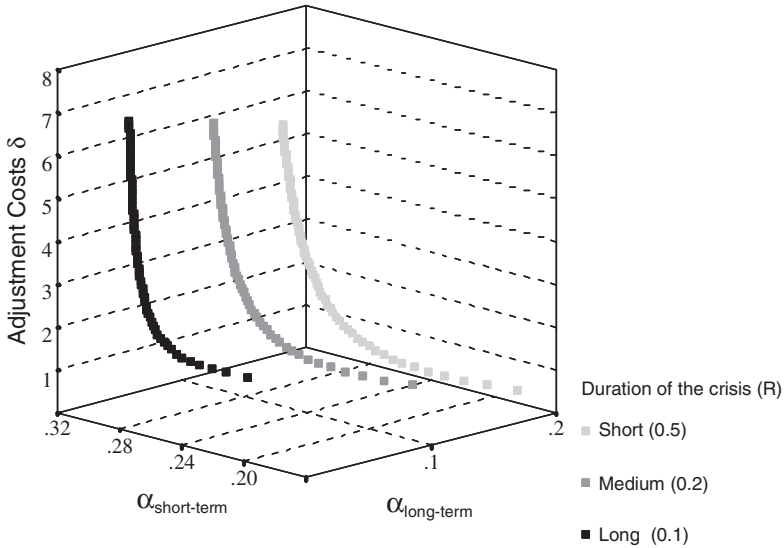


Fig. 3.3 Model simulation for expected short and long-term profitability reaction depending on δ (the adjustment costs) and *R* (expectation of the crisis duration)

²⁰ The results depend on different expectations of the duration of the crisis but, looking at the interest rate, the conclusions are exactly the same. In fact, the discount factor depends on both these variables and it is not possible to separate the two effects.

third line on the right side represents a carrier with an expectation of a short crisis. The points of each line identify carriers with different adjustment costs. The financial situation also modifies the location on the graph: the stronger is the financial constraint, the higher the sensitivity to short-term profitability, and the lower the sensitivity to long-term profitability. The main factors affecting the carriers' conduct and hence their positioning on the graph are their adjustment costs and expectation of the crisis duration. We expect that flexible carriers are located at the beginning of the curves, while non-flexible carriers are on the upper part of the curves.

3.5 Conclusions

This chapter has provided a theoretical analysis of the strategic conduct of European full-service carriers during the global crises in terms of short and long-term network strategy. In Chap. 2, we presented the network management as the process to develop and control the network (Sect. 2.4.2). The network management was described in terms of four levels: *network strategy*, *network design*, *alliances* and *network planning*. In this chapter, we referred to the short- and long-term strategy in order to analyse respectively, the network strategy and planning during the global crises.

In particular, we presented a dynamic game-theoretical framework organized in three stages, which are a time-continuous sequence of periods. In each period, carriers take operational actions (i.e. set the prices); choose their tactics (capacity supply); and follow a strategic plan (i.e. in the entire game they choose a strategy to solve the overall game). An important assumption of the model is the existence of positive adjustment costs, i.e. the costs required to re-expand capacity. Adjustment costs introduce rigidity in the carriers' conduct. Indeed, non-flexible carriers typically present a small reaction to short- and long-term variables. This behaviour results from the fact that a non-flexible carrier sets high capacity levels during the crisis to push its competitors out of the market and to reduce the set-up costs of re-entering. On the other hand, flexible carriers present high responsiveness to both short- and long-term profitability. They can be small during the crisis period to reduce the losses, and free to expand in the post-crisis period. Carriers' strategies are also affected by expectations of the crisis duration and on the strategic importance of the market. If a carrier expects the crisis to have a long duration (or the market is not strategically important), then its conduct shifts to the short-term variable. If the expected duration is short (or the market is strategically important), then the carrier bases its strategy on the long-term variable. In the next chapter, we will find some empirical evidence of these theoretical results. We will try to explain the carrier's capacity choices with two variables, which are proxies for short- and long-term profitability. These are the passenger reduction due to the shock, and the average revenue per passenger kilometre of the market.