

# 7 || Conclusions and discussion

## 7.1 Results

This dissertation focused on the interaction between consumer heterogeneity, product differentiation, and oligopolistic competition between suppliers of scheduled services in transport markets. Throughout this dissertation, the aviation industry was used as the main motivation and prime example of such a market.

The growth of low-cost carriers and major investments in high-speed rail in the last decade changed the nature of competition between scheduled service suppliers in aviation dramatically. Carriers and policy makers need to consider the challenges introduced by these changes in the competitive environment. For example, Chapter 6 studied consumer behaviour and oligopolistic competition in the London-Paris passenger market. In this market, a limited number of firms – low-cost carriers, legacy carriers, and high-speed rail – supply vertically differentiated products. Due to the improvements in high-speed rail, the high-speed rail operator is now a dominant supplier in this market. In order to assess the major public investments in high-speed rail, policy makers need to take into account a whole range of aspects, such as: the impact on local accessibility (Vickerman (1997) and Levinson (2012)); the environmental impact (Westin and Kågeson, 2012); network effects (Adler et al., 2010); and substitution and competition effects (Givoni and Banister, 2006). This dissertation developed an analytical framework to study the latter effect – i.e. competition – taking into account both observed and unobserved consumer heterogeneity, multiple-product firms, and exogenous and endogenous product differentiation.

Chapter 2 analysed patterns of vertical product differentiation in a multi-product monopoly with endogenous quality-then-price setting. Although monopoly pricing problems involving a product line have already been studied in the literature, for example Mussa and Rosen (1978), the model developed in this chapter extends and generalises these models by applying a random utility framework. This framework accounts for heterogeneity across consumers in unobserved attributes within the demand structure of the model. The few studies applying the random utility model to analyse oligopolistic quality-then-price competition – see Anderson and de Palma (1992a and 1992b) – report counterintuitive equilibria in which a single firm

supplies multiple variants with equal qualities and prices. In contrast, our findings show that including both observed and unobserved consumer heterogeneity supports the existence of both symmetric, asymmetric and fully differentiated equilibria. For relative low levels of unobserved heterogeneity, asymmetric and fully differentiated equilibria exist, whereas otherwise the equilibrium becomes symmetric. Furthermore, the analysis shows that the level of observed and unobserved consumer heterogeneity does not affect the relative efficiency of the monopolist compared with the social optimum.

Chapter 3 extended the model as outlined in Chapter 2 to a duopolistic market with endogenous quality-then-price setting, and with heterogeneity across consumers in both observed and unobserved attributes. This chapter analysed how consumer heterogeneity and strategic interaction between multi-product duopolistic firms may lead to vertically differentiated equilibrium patterns in terms of number of supplied variants, quality, and fare per variant. In a recent article, Cheng et al. (2011) prove the existence of a vertically differentiated subgame perfect Nash equilibrium. However, they exclude unobserved consumer heterogeneity and the possibility of interlaced equilibria. Chapter 3 accounted for both elements. Looking at the observed competition between a legacy carrier and a low-cost carrier, the analysis shows that both the high-quality- and the low-quality firm have limited incentives to provide an extra product variant at the lower end of the market. In fact, if consumer heterogeneity is based on observable attributes and it is costly to introduce new variants, an interlaced equilibrium does not exist. One of the major implications of including consumer heterogeneity based on unobserved attributes is that it restores the existence of interlaced equilibria within the endogenous quality-then-price setting model.

From Chapters 2 and 3 it became apparent that fully differentiated equilibrium patterns, accounting for both observed and unobserved consumer heterogeneity, only exist for relatively low levels of unobserved consumer heterogeneity. Furthermore, competition lowers the incentive for differentiation. The incentive for duopolistic firms to supply multiple vertically differentiated product variants is limited due to the fact that adding an extra variant causes more intensive competition over the whole product line. This lowers the mark-up of the high-quality product variants. Hence, for increasing levels of unobserved consumer heterogeneity, symmetric equilibria are observed earlier in a duopoly compared with a monopoly.

Chapter 4 contributed to a better understanding of the impact of frequent flier programs (FFPs) on actual consumers' usage levels. Although loyalty programs are key in firms' customer relationship management strategies in various industries, only a few empirical studies analyse the long term effects of such programs. This chapter addressed three major concerns mentioned in the literature: endogenous

participation decisions into FFPs (Leenheer et al., 2007); the two dimensions of consumer usage levels ((Liu (2007), Verhoef (2003), and Lewis (2004)); and the impact of changes in reward structure (Dorotic et al., 2011). The panel data used in this chapter covers a representative sample of active FFP members of a particular airline and includes actual usage levels over a three-year period. Halfway this three-year period, the airline changed its FFP by including status and non-linear token accrual in the program. This exogenous change in the FFP is used to find the effect of non-linear token accrual on consumers' purchase frequency and transaction size by formulating a two-stage budgeting model. A panel mixed logit model is specified to estimate the impact of this change on transaction size, i.e. fare type choice, in the second stage. In the first stage, a Poisson count data model is specified to estimate the impact of the change on the purchase frequency, i.e. the number of trips. In particular, the non-linear token accrual affects actual consumer usage levels positively. The estimates imply that after the change in the FFP, the average total individual consumer surplus of FFP members decreased by around 7 per cent of the average fare paid.

Chapter 5 studied the impact of product differentiation on capacity-then-price competition under demand uncertainty in a duopoly. Prior literature focuses on either the impact of demand uncertainty (Reynolds and Wilson, 2000) or differentiation (Benassy, 1989). The combination of both is therefore an innovative approach and extends the seminal work by Kreps and Scheinkman (1983). Depending on the realised demand after capacities have been chosen, the market in the pricing stage can be described as: contested monopoly, residual monopoly, or Bertrand Edgeworth duopoly. A subgame perfect Nash equilibrium in pure strategies exists, but only if the market is characterised by a sufficient level of vertical product differentiation. In line with Reynolds and Wilson (2000), our results show that if the difference in quality between firms exactly offset cost differences, asymmetric outcomes in the capacity stage arise. Apart from the impact on capacities, demand uncertainty and product differentiation also affect efficiency and price dispersion. The highest level of efficiency is reached at the degree of vertical product differentiation where it would be social optimal if firms had equal capacities. Furthermore, the findings show that vertical product differentiation leads to less dispersed prices of the high-quality firm, but to more dispersed prices of the low-quality firm. These results therefore provide an explanation for the ambiguous results found in empirical research on price dispersion in civil aviation by, amongst others, Borenstein and Rose (1994), Hayes and Ross (1998), and Gerardi and Shapiro (2009).

Chapter 6 studied inter and intramodal competition in the London-Paris passenger market over the period 2003–2009. The expansion of high-speed rail around the world, predominantly in Asia and Europe, and the planned developments in the

US, calls for an analysis of competition in these markets. Nevertheless, just a few studies have analysed intermodal competition thoroughly. These studies – González-Savignat (2004), Park and Ha (2006), and Ortúzar and Simonetti (2008) – are all based on stated preference data. In contrast, the study in this chapter employed a cross-sectional data set covering actual travel behaviour of passengers. After estimating separate mixed logit models for business -and leisure passengers, the estimation results are applied to analyse the reaction of passenger behaviour on the withdrawal of aviation alternatives and the completion of the High-Speed Rail link. Travel time and frequency are the main determinants of travel behaviour given the variation in attribute levels in the actual choice situations. The valuation of travel time changes over the years following the opening of the High-Speed Rail link. The withdrawal of aviation alternatives and the high frequency of the high-speed rail, combined with high consumer valuation of frequency, may cause competition to decline in the long run.

## **7.2 Implications and directions for further research**

This section discusses the methodological and practical implications – both for yield management and governmental policy – that follow from the analyses in this dissertation. In addition, possible limitations of the analyses, due to restrictive assumptions, and the associated implications for further research are outlined.

The results of Chapters 2 and 3 indicate that the random utility framework is applicable in modelling the mainly non-symmetric patterns of vertical product differentiation as observed in various industries. This finding implies that the random utility model can be used consistently to describe consumer behaviour in a vertically differentiated market where firm behaviour is exogenous, such as the empirical studies in Chapters 4 and 6, and to model strategic firm behaviour, like in Chapters 2 and 3.

Throughout this dissertation, the importance of consumer heterogeneity is apparent. The relative level of unobserved consumer heterogeneity determines which type – symmetric or asymmetric – of equilibria can be modelled within the random utility framework. Furthermore, the two empirical studies in Chapters 4 and 6 conclude that unobserved consumer heterogeneity may affect the choice for particular sets of alternatives differently than others. Therefore, this dissertation reconfirms the importance of capturing both observed and unobserved consumer heterogeneity in empirical studies, as well as including heterogeneity in theoretical studies. An important direction for further research is to increase our understanding of how to model and capture unobserved heterogeneity and the

accompanying limitations. For example, in the empirical literature there is a recent focus on discrete, latent class, mixture models to capture individual preferences.<sup>109</sup> One may apply these models to the empirical studies in Chapters 4 and 6 and compare the results with the ones reported applying continuous mixture models. A uniform distribution of the implied willingness to pay for quality is assumed throughout Chapters 2 and 3, one may study how different continuous and discontinuous distributions may affect the resulting patterns of product differentiation.

The results in Chapters 2, 3, and 4 provide some insights in yield management strategies for multi-product firms. From Chapters 2 and 3, it follows that the scope of multi-product strategies, in terms of number of variants and ordering of qualities, is limited. In fact, Chapter 3 shows that the marginal revenue of adding an extra product variant quickly approaches zero. In contrast to the current strategy of one of Europe's major low-cost carriers, easyJet, the model of vertical product differentiation does not support equilibria in which the low-quality firm supplies a high-quality variant in addition to the low-quality variant. Here, further theoretical research is needed to find the assumption that is responsible for this difference between real and predicted market behaviour. A first reason may be that instead of pure Nash behaviour, the low-cost carrier may expect that the high-quality firm only changes behaviour in the high-end of the market and will not consider the whole quality spectrum. Second, instead of assuming Cournot competition, the quality-then-price competition may be modelled as Stackelberg competition with the legacy carrier as the leader and the low-cost carrier as the follower. Third, in this dissertation we largely ignored the effect of cost differences between firms. Asymmetry in generic costs may obviously change the findings.

Chapter 4 identifies myopic behaviour of loyal consumers participating in a FFP as the main cause of an increase in consumers' usage levels. In particular, the non-linear token accrual and accompanying threshold values affects consumers' usage levels positively. Hence, the airline's FFP with its hierarchical three status levels has a mechanism at its disposition that changes the behaviour of FFP members in favour of the airline. This suggests that increasing the number of status tier levels, and therefore creating more threshold values, would help to exploit this mechanism even more. Although the results show that consumers experience a loss in surplus, the valuation of status by consumers is not explicitly measured. Therefore, one may argue that the reported loss in consumer surplus may already have been compensated for via the extra benefits of status. Further research to assess the monetary benefits of status in a loyalty program is therefore warranted. Furthermore, in order to determine the overall effectiveness of loyalty programs, one should also assess the costs of a loyalty program for the sponsoring firm.

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<sup>109</sup> See, for example, Greene and Hensher (2003), Hess (2007), and Shen (2009).

Changing the focus to governmental policy, this dissertation developed a framework to study the impact of heterogeneity and (endogenous) product differentiation in oligopolistic markets on consumer and firm behaviour. Although this framework enables to assess the impact of heterogeneity and differentiation on welfare, it has not been the intention to provide a full welfare assessment of current aviation policies. A potential important insight for competition policy regarding price dispersion is given in Chapters 2, 3 and 5. According to Dana (1999), a positive relationship between price dispersion and competition exists. In contrast, the results in Chapters 2 and 3 imply that, based on yield management strategies, intrafirm price dispersion diminishes with competition and equals zero in the extreme case of symmetric equilibria. Chapter 5 shows that intrafirm price dispersion, based on uncertainty in demand, may either increase or decrease with competition. Hence, a strict relationship between price dispersion and competition does not exist. Therefore, it is not straightforward to use price dispersion as a measure of collusion as suggested in the literature. Further research is required to study the combined effect of yield management and uncertainty in aggregate demand on the relation between the level of competition and price dispersion. Only if the source of the dispersion is known, one may normatively assess price dispersion and relate it to market functioning.

Finally, understanding how markets with only a few competitors function is crucial for yield management and governmental (transport) competition and investment policy. This dissertation is a step towards facilitating this understanding and extending it by including multi-product firms, product differentiation, and consumer heterogeneity.