The effect of airport expansion when airlines have market power

Fangni Zhang and Daniel Graham

Railway and Transport Strategy Centre, Department of Civil and Environmental Engineering,
Imperial College London, United Kingdom

Extended Abstract

Air traffic congestion is a headache for both airport and airline operators worldwide. Capacity expansion is often advocated as the remedy towards it. A third runway at Heathrow, for example, has triggered longstanding debates for decades. Economic development boosters and business leaders have long been clamoring that the lack of capacity at Britain's major airports causes them problems. Heathrow's expansion will greatly stimulate the local economy and strengthen London's hub status. Campaigners against the expansion argue that the increased pollution would substantially jeopardize the environment in both the local communities and the London area as a whole. Clearly airports create negative externalities, so it would be interesting and worthwhile to know whether the positive externalities they create are sufficiently large to offset the hazards.

Extensive studies have been carried out to examine the macroeconomic impact of airport expansion in terms of the employment or productivity growth (e.g., Batey, 1993; Brueckner, 2003) and agglomeration effects (e.g., Airports Commission, 2014). However, little attention is paid to the impacts of airport expansion from the microeconomic perspective. There is a growing body of microeconomic analysis of the pricing issues in the air transport literature. Pertaining to airport expansion, Zhang and Zhang (2003) investigated the time point at which an airport with a particular economic objective would add the capacity, and Zhang and Zhang (2006) examined the size of capacity provided by different types of airports, both base on nicely tractable models. However, the feedback effect of airport expansion has not been noticed.

Intuitively, airport capacity expansion relieves the capacity constraint to some extent and is expected to reduce the air traffic congestion. Nevertheless, the reality does not always run as expected. Figure 1 shows the timeline of the capacity expansion at Heathrow and the corresponding evolutions of average delay and the passenger movement along with the expansion, in which the total number of available seats is the proxy for the capacity. No patent improvement in the average flight delay can be found following the capacity jumps except in year 2008. In contrast, the average flight delay and total number of available seats exhibit similar trend most of the time. This shows that the effect of airport expansion on the level of service of the airport and airlines is questionable.
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Figure 1. Evolutions of capacity, passenger flow and average delay at Heathrow Airport  
(Source: Airports Commission, 2014 and UK Airport Statistics)

In road transport literature, researchers have identified numerous types of capacity paradoxes, in the sense that adding capacity to the road network or transit service network produces counter-productive results if the traffic inducing/diverting effect outweighs the direct benefits of capacity expansion. Following the same logic, airport expansion may also end up being counter-productive. The rational is as follows. Enlarged capacity would attract induced travels which in turn generates additional demand for airline operation. While airlines could also respond by tuning the airfares and schedules, three factors play important roles in driving the new equilibrium as well as interacting with each other: the scale of capacity expansion, airlines' 

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1 Analysis of Brass paradox for single mode systems can be found in e.g., Steinberg and Zangwill (1983) and Pas and Principio (1997), and the Downs-Thomson paradox for multi-mode systems can be found in e.g., Zhang et al. (2014, 2016).
responses, and passenger demand elasticities.\textsuperscript{2}

We start with a simple analytical example of the capacity paradox, i.e., added capacity leads to more severe congestion at the airport, using simple calculus. Consider a congested airport with the capacity of handling \( K \) identical flights during a certain period of time in the peak hour as in Zhang and Zhang (2003, 2006). Denote \( N \) the number of flights being actually operated by one or more homogeneous airlines and \( s \) the number of seats on each aircraft. Assuming each flight has the same loading factor, then the total passenger boarding \( Q \) during this period increases linearly with \( N \). The level of congestion, measured by the average delay per flight \( t_d \) increases with \( N \) (or \( Q \)) and decreases with \( K \). Given passenger’s willingness to pay, the actual passenger flow \( Q \) decreases with both the ticket fare \( \tau \) and the congestion delay \( t_d \). The relationship between the ticket price and the demand is not a priori clear. It depends on the market structure and operation regime of the airline. Ticket price may go down as demand boosts when the airline market is fully competitive and the operation exhibits increasing returns to scale, and the other way around otherwise. Suppose that the average delay function calibrated from a particular airport takes the form \( t_d = \tilde{t_d} Q^\alpha K^\beta \), and the passenger demand function \( Q = \tilde{Q}^\gamma t_d^\lambda \), where \( \tilde{t_d}, \tilde{Q}, \alpha, \beta, \gamma, \) and \( \lambda \) are all positive parameters. As the relation between ticket price and demand is unclear, it is captured by function \( \tau = \overline{\tau} Q^\eta \), where \( \overline{\tau} \) is positive while the sign of \( \eta \) is undetermined. Substituting the latter two equations into the former one gives \( t_d = \bar{t_d}' K^{\frac{\gamma}{1+\frac{\alpha}{\gamma}}}, \) where \( \bar{t_d}' = \left( \bar{t_d}^{1+\gamma} \tilde{Q}^\alpha \overline{\tau}^\gamma \right)^{\frac{1}{1+\gamma+\alpha}} \) is a positive constant. When \(-\frac{\alpha+1}{\gamma} < \eta < 0\), \( t_d \) increases with \( K \). In other words, as long as the airfare is adjusted in the reversed direction with the passenger demand at a moderate rate (not exceeding \(-\frac{\alpha+1}{\gamma}\)), the airport will get more congested after the capacity expansion.

The above example shows that the benefits of airport expansion can be deprived simply by a divergent fare rule. According to Zhang et al. (2014, 2016), the effect of road expansion on a bimodal system depends not only on the fare rule, but also how the transit operator changes the service frequency and how travelers chooses between the modes (i.e., car or transit). Operators with different economic objectives react distinctly to road expansion which leads to various outcomes in the new equilibrium. Analogously, the effect of airport expansion should be systematically examined with market structure of airlines, flight schedule and airfare decisions, and passenger demand elasticities taken into account.

This study contributes to the literature by investigating these important questions: (a) how

\textsuperscript{2} Even though in the long run the effect of airport expansion would be affected by other exogenous factors such as new technologies of navigation and traffic management, they are ignorable in the short run.
airlines would respond to airport expansion in different market structures; (b) under what conditions the capacity expansion improves the system performance when the new equilibrium is reached; (c) what would be the impact on user benefits. In particular, the basic model is adapted from Zhang and Zhang (2006). With a focus on a single hub airport, three typical forms of the market structure are considered for the airlines: competitive, monopolist and Cournot oligopolist.

References


