How do firm and market characteristics affect airports Beta risk?

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Abstract

I present a graphical framework based on Subrahmanyam and Thomadakis (1980) that allows to study the impact from firm and market characteristics on systematic risk associated with the return on capital, i.e. Beta risk, for utilities under price control. Within this framework, Beta risk is driven by the magnitude of profit fluctuations following demand shocks.

The framework is then applied to airport firm characteristics and airport market environment features. I find that the frequency of price control resets, the level of operating leverage, the extent of capacity constraints, and the degree of market power all have an unambiguous effect on the level of Beta risk. The scope of the regulatory perimeter and the type of traffic mix may also affect Beta risk; however, the magnitude and direction of their impact rely on the specifics of the case.

The article may assist policy makers to formulate economically sound recommendations on how the regulatory rate of return for airport operators should be determined. Specifically, my findings suggest criteria that can be used to choose adequate peer companies of comparable systematic risk.

1 Introduction

The Council of the International Civil Aviation Organization (ICAO) encourages states to follow the four internationally agreed principles of non-discrimination, cost-relatedness, transparency, and user consultation when determining airport charges.[1] The principle of cost-relatedness states that users should ultimately bear their full and fair share of the cost of providing the airport services. Naturally, this includes a fair rate of return on capital.

In the EU, the ICAO principles were reflected in the 2009 Directive on airport charges (the Directive), which mandates, inter alia, that member states nominate an independent supervisory authority (ISA) to ensure that airport charges do not exceed competitive levels and that the underlying determination process is transparent. In order to foster a common implementation of the Directive, the European Commission created an expert group named Thessaloniki Forum of Airport Charges Regulators (Thessaloniki Forum) and tasked it with the creation of guidelines on how to determine airport charges.

In 2016, the Thessaloniki Forum recommended using the Capital Asset Pricing Model (CAPM) to determine airports' cost of equity. Exchange-listed peer companies may be used as benchmarks to estimate the extent of systematic risk associated with the return on capital. However, the Thessaloniki Forum does not specify how peer companies should be selected.

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[1] See ICAO's Policies on Charges for Airports and Air Navigation Services, Ninth Edition, 2012, https://www.icao.int/publications/Documents/9082_9ed_en.pdf

In this article, I present a graphical framework rooted in basic microeconomic principles that can be used to study how differences in the regulatory environment, differences in firm and supply characteristics, and differences in demand and market structure affect the extent to which regulated airports are exposed to systematic risk. The findings of this paper may prove useful to create or extend guidelines on how to select peer companies for the determination of airports' cost of equity.

The remainder of the article is structured as follows:

- Section 2 presents a graphical framework that allows to assess the effects arising from market and firm-specific characteristics on systematic risk.
- Section 4 studies the impact of regulation-related factors, specifically the frequency of regulatory resets and the scope of the regulatory perimeter, on airports' Beta risk, using the framework from the previous section.
- Section 5 illustrates how supply-related factors, specifically the degree of cost fixity and the existence of capacity constraints, affect airport Beta risk.
- Section 5 illustrates how factors related to demand and market structure, specifically airport-specific traffic mix and market power under price cap regulation, affect airport Beta risk.
- Section 6 concludes.

2 Economic regulation, capital costs, and investment

The EU Directive on airport charges does not specify a common charging mechanism. Member states have implemented price control regimes that vary to a large degree (Steer Davies Gleave, 2017). Economic regulation ranges from light-handed forms without explicit ceilings (e.g. Swedish airports in the Swedavia network) to incentive regulation based on multi-year RPI-X price cap regimes (e.g. the main airports in the United Kingdom and Ireland). Price controls are implemented directly by the ISA (e.g. in the case of London Heathrow) or they are agreed upon between the airport and its users before they are endorsed by the ISA (e.g. London Gatwick or Zurich). Some price control regimes define a single cap per passenger (e.g. Dublin), whereas others outline detailed tariff structures depending on type, size, weight, and other aircraft and traffic characteristics (e.g. the Economic Regulation Agreements for Parisian Airports).

Independent of how the directive is implemented, ISAs will want to ensure that the allowed rate of return on capital, which is implicit in the chosen price control scheme, allows airports to attract the necessary funding to finance their investments. Albeit ISAs will be reluctant to allow a rate of return that materially exceeds the level of capital costs, as this would result in unnecessarily high charges for airport users. Thus, regulators will typically aim for a regulatory rate of return on capital that is close to the level of capital costs.

In line with the Thessaloniki forum guidelines, most European ISAs use a WACC-CAPM framework to estimate capital costs and determine the regulatory rate of return. The WACC is the weighted average of the cost of equity and the cost of debt with weights in the ratio of the airport's capital structure.

While estimates for the level of the cost of debt may be readily available in the form of information on the airport's actual interest payments, the level of cost of equity is more difficult to observe. Actual returns on equity bear little informative value, as they could be above or below capital costs. In the absence of regulation, most airports enjoy a degree of market power that allows them to charge prices above competitive levels, resulting in returns that exceed capital costs. On the other hand, the physical specificity of airports means that they have very little value for alternative uses. Thus, costs for airport investments are typically sunk, implying that the minimum level of returns investors require to continue operating the airport may be lower than the returns required to invest (i.e. the level of capital costs) (see e.g. Spiller, 2013).

Accurate estimates of the cost of capital may be retrieved from secondary financial markets data. The Capital Asset Pricing Model (CAPM), which was developed in the 1960s based on Markowitz' (1952) portfolio theory, forms the theoretical basis underlying the most common approach to estimate the level of the cost of equity. It is rooted in the idea that investors require a premium for holding risky assets with undiversifiable yield fluctuations compared to holding risk-free assets such as government bonds (e.g. Lintner, 1965; Mossin, 1966; or Sharpe, 1964). The level of the premium is determined by the CAPM's Beta coefficient (or simply Beta), which describes the proportionality between the asset's returns and the returns of a perfectly diversified portfolio, i.e. the asset's systematic risk.

Only if the allowed regulatory rate of return adequately reimburses investors for the airport's systematic risk, they are willing to invest. Getting the Beta value right is therefore a key task for ISAs independent of the type of economic regulation that is put in place. The right Beta ensures affordable access to airport users while securing the funding opportunities required for investments.

Using regression analysis, ISAs could in theory estimate an airport's Beta directly from financial stock data. In practice however, most regulated airports are not listed and regulators will have to rely on evidence from benchmark airports to determine the Beta. However, the choice of adequate comparator airports is frequently the cause of arguments between ISAs and airport operators, as views on whether candidate airports are suitable benchmarks may greatly vary.

3 Framework for translating demand uncertainty into Beta risk

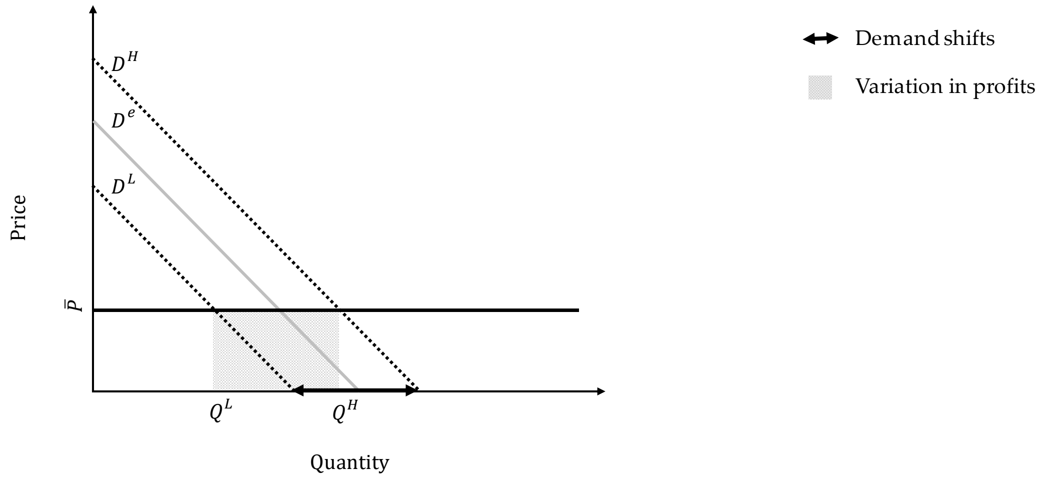
Several studies have attempted to connect the theory of the firm and the CAPM to assess how specific market and firm characteristics affect the level of systematic risk to which firms are exposed to. Subrahmanyam and Thomadakis (1980) were among the first to develop a formal model that pinpoints the microeconomic determinants of systematic risk in a single-period model. Their model describes the correlation between an individual firm's value (captured as the firm's future cash flows) and the aggregate value the overall economy (captured as future cash flows of all firms in an economy). All firms in the economy are exposed to demand shocks of similar direction and magnitude, which can be subsumed as fluctuations of aggregate demand. The individual firm's systematic risk is determined by how its specific characteristics pronounce or flatten changes in future cash flows from demand shocks relative to the changes in future cash flows of the aggregate economy.

Subrahmanyam and Thomadakis' work focuses on the relevance of factor proportions. As such, their model is specifically designed to answer how a specific firm's labour-capital ratio affects the level of its Beta risk. Given that this article is concerned with a much broader set of potential risk drivers, the details of their model are not of particular interest for the framework of my analysis.

Nevertheless, the basic idea underlying Subrahmanyam and Thomadakis' and others' model is insightful and will also constitute the basis of my framework. Shocks in demand for air travel (i.e. passenger numbers) are closely correlated to shocks in aggregate demand. Whereas shocks in aggregate demand are responsible for fluctuations in the value of the market portfolio, shocks in demand for air travel are responsible for fluctuations in the value of airport equity. The degree to which demand shocks for air travel translate into profit fluctuations depends on airport-specific market and firm characteristics. Characteristics that cause profits to fluctuate more (less) imply a higher (lower) Beta risk.

I use a less formal, but more flexible graphical setup than Subrahmanyam and Thomadakis to analyse the relation between demand shocks and profits. **Figure 1** illustrates the framework, which portrays passenger volumes (i.e. demand outturn) and profits for an airport under price controls. Demand shocks are modelled as shifts in a linear demand function away from the expected level. The extent to which profits vary between low demand outturns (D^L) and high demand outturns (D^H) is indicated by the grey rectangle. Since profit fluctuations are correlated with the yield of the market portfolio, the size of the rectangle reflects the extent of systematic risk an airport is exposed to – the larger the area, the higher the systematic risk. The size of the area is determined by airport-specific firm and market characteristics.

Figure 1: Graphical framework



Note: The level of the price cap ($\bar{P}$) is set so that under expected demand (D^e) the airport can recover its total costs. Demand shifts (D^e to ^{L}or D^e to D^H) are assumed to be perfectly correlated to shocks in aggregate demand. Therefore, demand uncertainty is a source of systematic risk – and within the framework the only source of systematic risk. The area of the grey rectangle indicates the extent of systematic risk the airport is exposed to. To avoid unnecessary complexity, marginal costs are assumed to be 0 if not indicated otherwise.

Source: Own illustration.

Clearly, the precise structure and shape of demand that airports face is much more complex than is depicted by the stylised linear demand curve of my framework. However, the key mechanism that is illustrated, i.e. how economy-wide demand shocks translate into profit fluctuations and systematic risk, does not depend on the details of the airport's demand function.

However, some differences of my framework to Subrahmanyam and Thomadakis' work are worth explicit mentioning. My framework is limited to the analysis of uncertainty around demand outturns. In contrast, Subrahmanyam and Thomadakis consider economy-wide labour cost shocks as a second concurrent source of uncertainty that impacts firms' systematic risk. It is differences in factor proportions that translate economy-wide labour cost shocks into impacts on systematic risk of different magnitude. However, for the specific case of airports, factor proportions are unlikely to be an important driver of Beta risk. Unlike demand shocks, that are likely to have a common effect on many airports, labour cost shocks are of a more local nature and less correlated across airports. Thus, the effect of omitting labour cost shocks from the analysis should be negligible. This is especially the case, since Subrahmanyam and Thomadakis do not find any interaction effects from labour costs on demand uncertainty that would invalidate their findings. Though, it is likely that there exist drivers of systematic risk unrelated to microeconomic firm and market characteristics that are not captured by my framework. One obvious example is financial leverage, as Hamada (1972) has shown in his seminal paper on the effect of capital structure on systematic risk.

Subrahmanyam and Thomadakis use a model of quantity competition, where all firms set their optimal output before the uncertainty term in the (inverse) demand function is revealed. Thus, their output is fixed, but their pricing adjusts depending on the realisation of demand. This modelling choice is made to simplify the analysis and avoid countervailing effects on firms' profits from output adjustments. In my framework, adjustments to plan passenger numbers (i.e. output) are not restricted. This is a natural and necessary extension for the airport business with great uncertainty around passenger outturn. Given the focus of my assessment is on airports under price control, this amendment to the framework does not complicate the analysis. Instead of output, I assume prices to be fixed. This is a more appropriate assumption, given that airports under price control are typically constrained in adjusting their prices following demand fluctuations.

4 Factors related to economic regulation

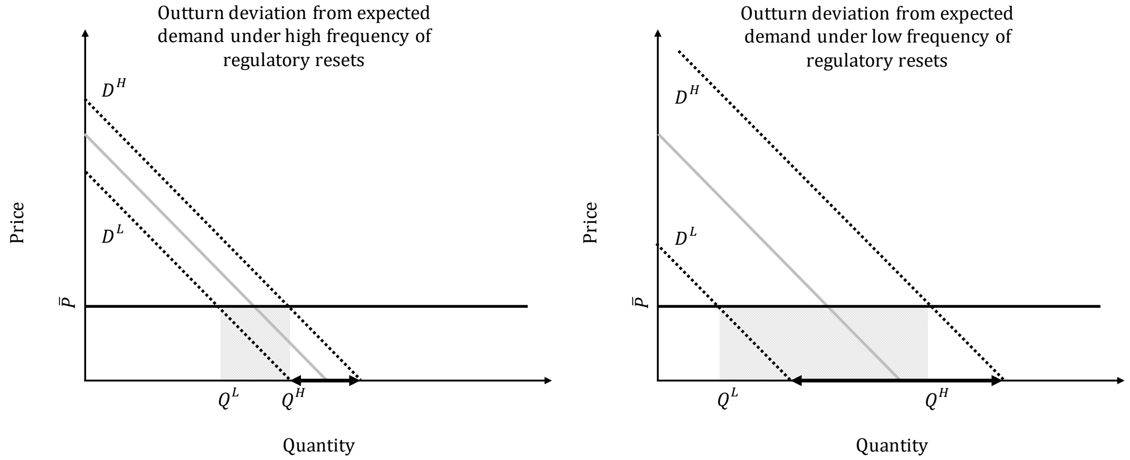
Economic regulation defines how economic value and risks are shared between users and airport operators. In that respect, the specific parameters under which an airport is regulated, are likely to influence its exposure to systematic risk.

4.1 Frequency of price cap resets

Under price control, risks related to demand shocks are typically mitigated through a periodic reset of the cap and its fundamental cost assumptions (e.g. forecasts of traffic, Opex, RAB, etc.). With every reset of the regulatory parameters, expected revenues are brought in line with expected costs. The shorter the time period between resets (i.e. the length of the periods during which the airport operator effectively bears the risks) the smaller is the demand risk for the regulated entity. For example, Heathrow Airport's price cap regulation with regulatory periods of 5 years increase the airport's incentives to become more efficient, but it also leads to greater exposure to demand uncertainty (especially in the later years of the regulatory period). Thus, a key factor that determines the extent of demand risk is the length of the regulatory period.

The difference in the sizes of the rectangles left and right in **Figure 2** illustrates the effect of varying frequency of a reset of the price cap. A higher frequency of resets (e.g. every year) means that demand outturn will remain closer to demand forecasts compared to a lower frequency of resets (e.g. 5-year regulatory periods). Over short periods of time, fluctuations in passenger numbers can be predicted with good accuracy via flight schedules and industry forecasts. Over longer regulatory periods of 4 to 5 years, forecasts are less precise and passenger outturns are likely to deviate more from expected levels.

Figure 2: Frequency of price cap resets and systematic risk



Note: Expected magnitude of demand shifts (D^L to D^H), i.e. the deviation of passenger outturn from expected passenger volume, depends on the frequency of resets of regulatory parameters like passenger forecasts. Passenger outturn is likely to deviate more from expected levels when resets are less frequent, as trends are more likely to change unexpectedly. The extent of profit variation, which is caused by demand shifts, is increased with higher frequency of resets, as indicated by the different sizes of the grey rectangles.

Source: Own illustration.

Other forms of regulatory intervention may have a similar impact. For example, some airports have risk sharing agreements with respect to passenger numbers, which automatically trigger an adjustment to the price cap when outturn exceeds a certain threshold.[2] Other regulators have the statutory discretion to intervene within regulatory periods and adjust price caps under certain conditions (e.g. when an airport's profits or losses are considered excessive).[3] Also, forms of regulation that cap overall revenue rather than tariffs per passenger (i.e. revenue caps) enable the airport to increase contribution margins in the case of low passenger outturns and force it to decrease contribution margins in the case of high passenger outturns.

In terms of Beta risk, these forms of economic regulation are comparable to an increased frequency of price cap resets, as they serve to reduce the financial risk to airport operators arising from deviations in passenger outturn from expected passenger levels.

4.2 Scope of the regulated perimeter

Under Single Till regulation, revenues and costs from certain commercial activities (e.g. retail, property, car parking, and advertising) are reflected in the level of the price cap i.e. expected profits from these activities are subtracted from expected costs of aeronautical activities. The level of the price cap under Single Till regulation is lower than under Dual Till regulation.

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[2] For example, the current Economic Regulation Agreement between the French Government and Aéroports de Paris Group regarding the economic regulation of the Parisian airports contains clauses to adjust the price cap depending on a traffic outturn. If traffic exceeds the volume threshold in a given period, 50% of the surplus will be offset by a negative adjustment to the cap in the following period. See Economic Regulation Agreement between the Government and the Aéroport de Paris 2016-2020, Page 17.

[3] For example, the Swiss Ordinance on Airport Charges enables the regulator to intervene and adjust the level of the price cap at any time if it starts to diverge from the principles set out in the law code. See Ordinance on Airport Charges (2012), Article 11, Paragraph 2, https://www.admin.ch/opc/en/classified-compilation/20110517/201206010000/748.131.3.pdf

Like aeronautical revenues, commercial revenues are closely correlated to aggregate demand. Thus, when aggregate demand turns out below expectations, both, profits from commercial revenues as well as revenues from airport tariffs, fall below their expected level. Thus, in absolute terms, the fluctuation in profits is higher under Single Till regulation than under Dual Till regulation. However, Single Till regulation does not only encompass more revenue categories, but it also implies a larger asset base. All assets required to generate the commercial revenues included in the till are also included in the RAB. Thus, in relative terms, e.g. expressed as return on capital employed, it is unclear whether the variance in profits is larger under Single Till or Dual Till regulation.

Complicating things further, it is unclear whether commercial revenues react more or less to changes in aggregate demand than passenger numbers. Empirical evidence on elasticities for various types of commercial revenues and passenger numbers with respect to changes in GDP is inconclusive. In their recent 2019 Determination, the Irish Commission for Aviation Regulation (CAR) has found elasticities close to 1 for many revenue categories (including retail, car parking, and property) as well as for passenger numbers, indicating that GDP elasticities are comparable (CAR, 2019).

In summary, the overall effect from the regulatory perimeter on systematic risk depends on the specifics of the airport. It depends on the elasticity of relative profit levels with respect to changes in aggregate demand, which is likely driven by the type of revenue categories included in the till and their capital intensity.

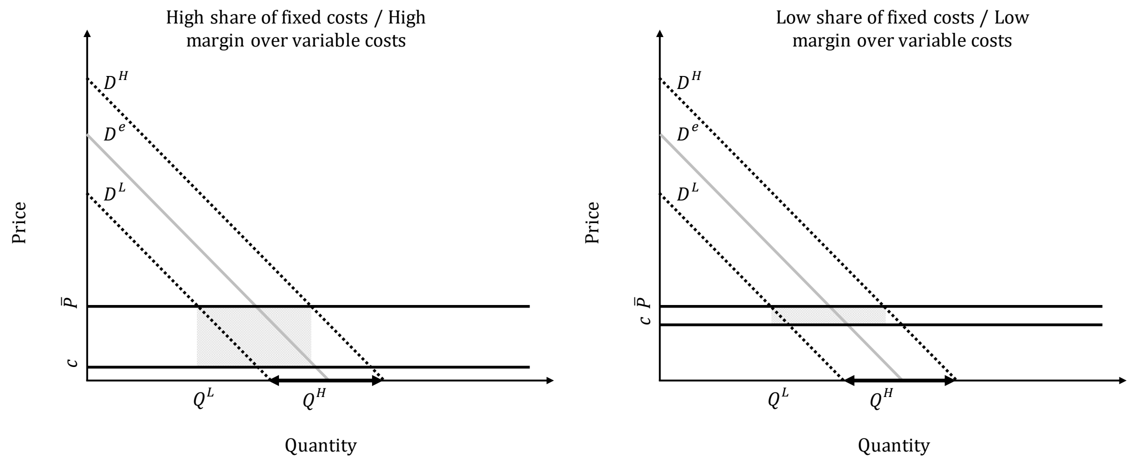
5 Factors related to supply and firm characteristics

Airports' cost structure and other factors related to supply can affect how demand shocks translate into profit fluctuations. In the following, I illustrate the effect of cost fixity and capacity constraints on systematic risk.

5.1 Cost fixity

The degree of cost fixity, i.e. the share of fixed costs in total costs, affects airports' operating leverage. Airports with a larger share of fixed costs may find it more difficult to adapt their cost levels to demand shocks than airports with a smaller share of fixed costs. In the event of a demand downswing, an airport with a higher share of variable costs experiences less profit erosion than an airport with mainly fixed costs. **Figure 3** illustrates this graphically.

Figure 3: Cost fixity and systematic risk



Note: The level of marginal costs (c) relative to the level of the price cap ($\bar{P}$) indicates the ratio between variable and fixed costs. It is assumed that under price cap regulation, mark-ups over marginal costs are set so that fixed costs can be recovered. Profit fluctuations decrease with higher shares of variable costs, as indicated by the different sizes of the grey rectangles.

Source: Own illustration.

This intuitive finding was also demonstrated in several academic papers. For example, Lev (1974) uses a more formal, but from a conceptual point of view identical approach to mine, when he finds that systematic risk is positively correlated with operating leverage (and therefore cost fixity).

Thus, regulators may want to look at Capex/Opex ratios or other measures of cost fixity (e.g. the level of recent and planned investments, historical passenger elasticities of Totex, or operating leverage) when assessing whether airports are comparable in terms of Beta risk.

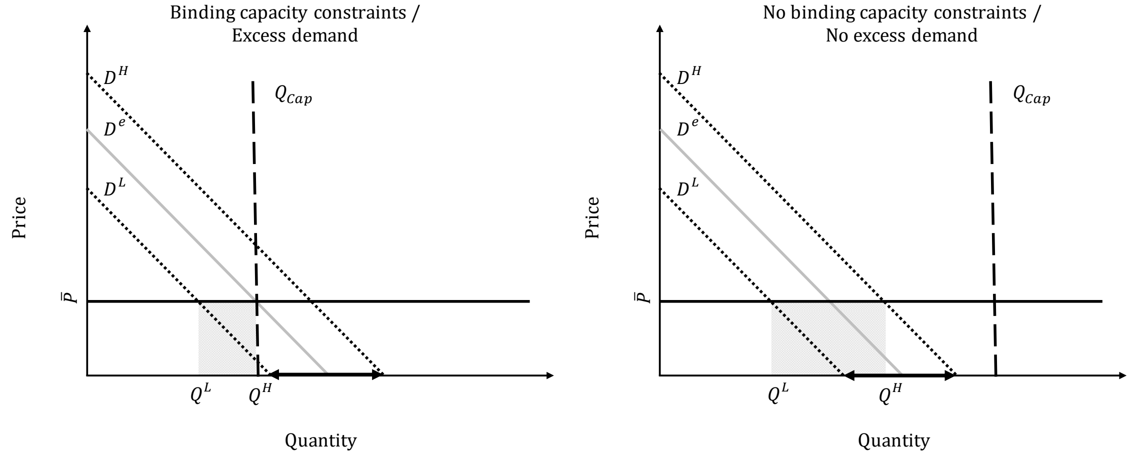
5.2 Capacity constraints

Capacity constraints may be another reason for why systematic risk differs across airports. In a free market situation, absent of price regulation, supply and demand typically clear at the level of market prices. However, under a price cap regime it is possible that prices are set so that some excess demand remains without being supplied. Given cost-based airport tariffs, some airlines may be willing to acquire more slots than an airport's capacity allows for.

In the presence of excess demand, slots are allocated to airlines through other mechanisms than solely based on willingness to pay. For example, slots at capacity constrained airports in the EU are typically allocated through so-called ´grandfathering rights´, which consider an airline's previous use of slots (e.g. Directorate-General for Internal Policies, 2016).

Binding capacity constraints imply that airport profits are affected less from demand shocks than when high demand outturns can be fully accommodated. **Figure 4** illustrates the effect of capacity constraints and excess demand on the variance of profits.

Figure 4: **Spare capacity and systematic risk**



Note: Capacity constraints (Q_{Cap}) reduce the variation in profits caused by demand shifts if they result in excess demand not being served, as portrayed by the different sizes of the grey rectangles.

Source: Own illustration.

Airport capacity is determined by runway capacity, flight regulation, terminal size, and other factors. Regulators may want to look at utilisation measures for these bottle necks in order to understand whether systematic risk between airports is comparable.

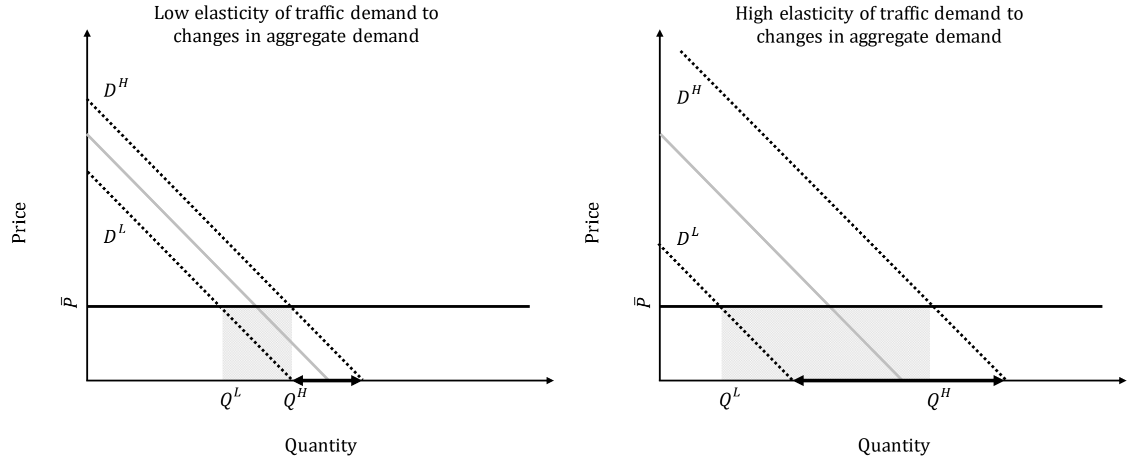
6 Factors related to demand and market structure

Finally, demand-related factors and market structure may also play a role in determining airports' Beta risk. I illustrate below potential effects from airport-specific traffic composition and market power on systematic risk.

6.1 Traffic mix

The extent to which air traffic demand reacts to changes in aggregate demand may differ between airports depending on the composition of their traffic. Certain demand segments are likely to show systematically different elasticities to changes in aggregate demand compared to other demand segments. **Figure 5** illustrates the effect on the magnitude of profit fluctuations from demand shocks whose extent is determined by the airport-specific traffic mix.

Figure 5: Traffic mix-dependent demand shifts and systematic risk



Note: The expected magnitude of demand shifts in passenger numbers (D^L to D^H) increases when its elasticity with respect to aggregate demand increases. Higher elasticity of passenger demand with respect to aggregate demand results in increased profit variation, as portrayed by the different sizes of the grey rectangles.

Source: Own illustration.

Academics and practitioners have conducted numerous empirical studies that estimate price elasticities in the air travel sector for various demand segments (e.g. Gillen, Morrison and Stewart, 2007; or Carlsson, 1999). However, price elasticities are of limited use to assess how air traffic demand changes when aggregate demand changes. More informative is research on elasticities, that measure how air traffic demand reacts to changes in travellers' income (e.g. proxied by GDP measures). However, empirical literature has been less concerned with differentiating income elasticities for different demand sectors than for price elasticities. Although several empirical studies have estimated average income elasticities for air traffic demand, few have differentiated between various demand segments (e.g. Njegovan, 2006). One exception is IATA (2007), which finds that longer haul flights generally have a higher income elasticity than shorter haul flights (see IATA, 2007, page 37). There may exist systematic differences between other demand segments (e.g. business vs. leisure passengers, domestic vs. international traffic, low cost carriers vs. full service carriers), but the empirical evidence is sparse.

Nevertheless, airport regulators may want to focus on airports with similar traffic composition when selecting comparator airports to inform the level of the Beta.

6.2 Price elasticity of demand and degree of market power

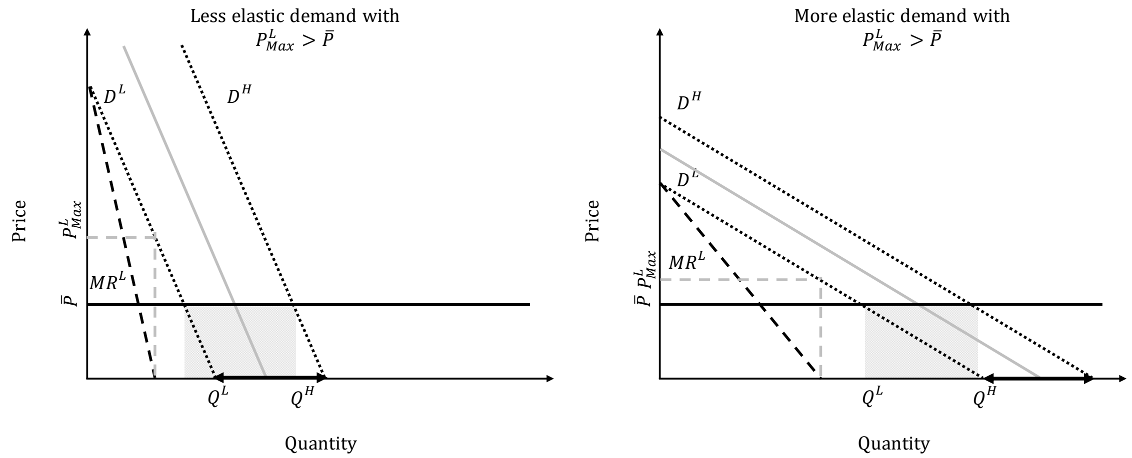
The level of Beta risk faced by airports may be affected by differences in the price elasticity of firm-specific demand across airports. Price elasticity of firm-specific demand may depend on the airport's degree of market power.

The relation between Beta risk and market power has been the subject of several academic studies (e.g. Sullivan, 1978). Most theory-based work has found that market power decreases Beta risk Firms with market power can adjust their prices to demand shocks, which reduces the impact on profits compared to firms with little leeway in terms of pricing. Surprisingly however, despite the Beta's particularly important role in the context of economic regulation, little formal research has been conducted on the effect of market power on Beta risk under price regulation.

When prices are capped at a level that approximately allows airports to recover their total costs, mark-ups over marginal costs are set so that passenger volumes under expected demand suffice to cover fixed costs. When demand outturn is high, the regulated airport makes an economic profit and when demand outturn is low, the regulated airport makes a loss.

As long as the level of the profit-maximising price remains above the level of the cap, airports will set a tariff at the level of the cap independent of whether demand outturn is higher or lower than expected. The precise shape of the demand curve (and as such price elasticity of demand) does not matter. Profit fluctuations from demand shocks do not depend on the price elasticity of demand. **Figure 6** illustrates this.

Figure 6: Price elasticity of demand and systematic risk when profit-maximising prices remain above the cap

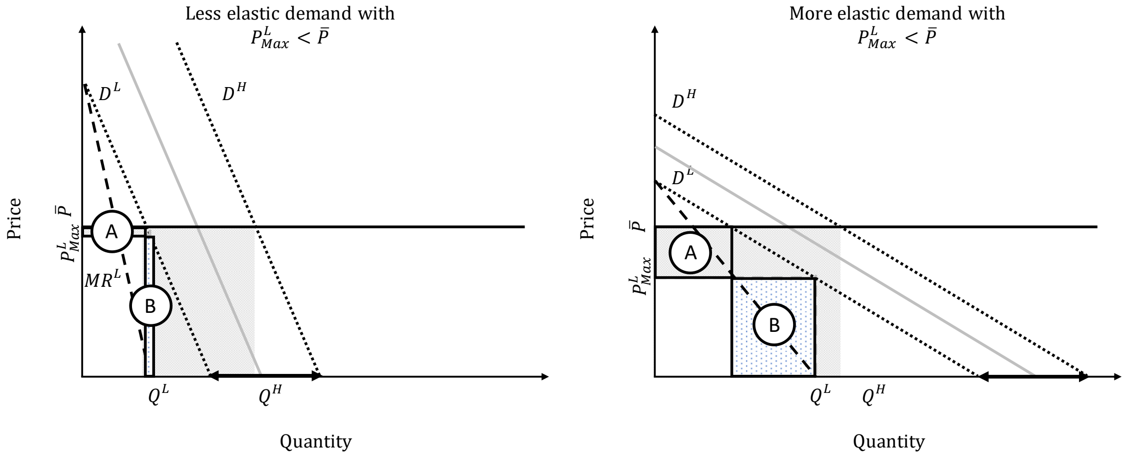


Note: In this scenario, market and firm characteristics are such that the profit maximising price level (P^L_{Max}) remains above the cap ($\bar{P}$) under low demand outturn (D^L). The airport always charges a price at the level of the cap. The level of the profit maximising price depends on the shape of the demand curve and is defined by the condition that marginal revenue equals marginal costs ($MR^L = 0$). The level of the price cap on the other hand is determined by expected demand and the level of fixed costs. The variation in profits is independent of how price sensitive demand is, as indicated by the constant areas of the grey rectangles.

Source: Own illustration.

However, when profit-maximising prices fall below the level of the cap under low demand, airports will find it optimal to reduce their tariffs. In this case, airports with more elastic demand have an advantage compared to airports with less elastic demand. They can protect their revenues more effectively by reducing tariffs below the cap, as their passenger volumes react more to price cuts than passenger volumes at airports with less elastic demand, as illustrated in **Figure 7**.

Figure 7: Price elasticity of demand and systematic risk when profit-maximising prices fall below the cap



Note: In this scenario, market and firm characteristics are such that the profit maximising price level (P^L_{Max}) falls below the cap ($\bar{P}$) under low demand outturn (D^L). The airport lowers its price from the cap to the new profit-maximising price when demand is low. The level of the profit maximising price depends on the shape of the demand curve and is defined by the condition that marginal revenue equals marginal costs ($MR^L = 0$). The level of the price cap on the other hand is determined by expected demand and the level of fixed costs. The variation in profits decreases with more elastic demand, as indicated by the reduced area of the grey polygon.

Source: Own illustration.

Figure 7 illustrates a situation under linear demand and no marginal costs. When demand outturn is low (D^L), the airport finds it optimal to reduce prices below the cap (from $\bar{P}$ to P^L_{Max}). By sacrificing some margin (rectangle A), the airport generates additional passenger volumes (rectangle B). Overall revenue increases compared to the level at the cap. Rectangle B will always be larger than rectangle A. With increasing demand elasticity however, rectangle B grows faster than rectangle A.

Decreasing the price from the level of the cap to the profit-maximising level implies moving from elastic price elasticity to unitary price elasticity of demand. At this point, the negative effect of further price cuts outweighs the positive effect from accompanying volume increases. Assuming identical passenger volumes at the level of the cap, the profit-maximising level of the price decreases with increasing elasticity of demand and the profit-maximising level of passenger volumes increases with increasing elasticity of demand. Airports facing more elastic demand will want to lower their prices a little more than airports facing less elastic demand, as they can protect more profits.

In practice, regulators who want to understand whether airports are comparable in terms of Beta risk may try to answer the following questions:

- **Do airports consistently charge tariffs close to the cap?** If airports' prices remain close to the cap even during low demand outturns, market structure is such that differences in price elasticity of demand do not affect airports' Beta risk.
- **How can differences in price elasticity of demand be measured with reasonable effort?** A main determinant of firm-specific price elasticity is market power. Given that the existence of significant market power is the reason for why airports are regulated in the first place, it is likely that most airports are not faced with substantial competitive constraints. However, practitioners have identified several sources of potential competitive pressure on specific aeronautical revenues (e.g. Oxera, 2017):

- **Competition for transfer passengers**: Intercontinental traffic and long-haul traffic in general is often organised over hub and spoke systems, i.e. services for distant city-pairs are connected through stopovers in hub airports. Naturally, connecting passengers are more contestable than O/D passengers due to airlines' ability to divert passenger streams through alternative routes. For hub airports (e.g. London Heathrow, Frankfurt Fraport, or Amsterdam Schiphol), connecting passengers may represent a significant share of total passengers.
- **Competition for airline bases**: In order to create scale efficiencies, most airlines operate from bases that allow them to concentrate maintenance work for aircraft. Naturally, airline bases are attractive for airports, as they typically imply more routes and higher passenger volumes. However, airlines can shift aircraft across bases or open and close whole bases on relatively short notice as has been evidenced by Ryanair recently for example.[4]

Thus, regulators may draw conclusions on comparability of airports with respect to Beta risk by assessing the degree to which their demand relies on transfer passengers and airline bases.

7 Conclusion

In this article, I presented a graphical framework to illustrate the effect of firm and market characteristics on airports' exposure to Beta risk. I have shown how the specifics of economic regulation, the structure of the firm and supply, as well as the composition of demand and market characteristics may affect systematic risk. **Table 1** summarises my findings.

[4] Ryanair announced to close bases at Las Palmas Airport, Tenerife South Airport, Lanzarote Airport, Girona Airport, Nuremberg Airport, and Stockholm Airport in 2019. See for example https://www.rte.ie/news/business/2019/0823/1070574-ryanair-to-close-4-spanish-bases-next-year-union/

Table 1: Summary of firm and market characteristics affecting airports' Beta risk

Firm and market characteristics	Impact on Beta risk
Frequency of price cap resets	The frequency of price cap resets determines the extent to which passenger outturn may deviate from expected levels. A higher (lower) frequency of resets decreases airports' systematic risk, since passenger outturns remain closer to (fall further from) expected levels than under lower frequency of resets.
Regulatory perimeter	The impact of the regulatory perimeter on systematic risk depends on the type of the commercial activities in question. Beta risk increases (decreases) with the scope of the regulatory perimeter if profits from commercial revenues have a higher (lower) elasticity with respect to changes in aggregate demand than aeronautical revenues.
Cost fixity	Cost fixity determines an airport's operating leverage, which in turn influences the extent of profit variation following demand shocks. A higher (lower) share of fixed costs translates into higher (lower) profit variation following demand shocks and therefore higher (lower) Beta risk.
Capacity constraints	Under price cap regulation, capacity constraints can impact the extent of profit variation from fluctuations in traffic demand. Binding capacity constraints reduce Beta risk of an airport under price cap regulation. Profits are foregone when demand exceeds capacity in times of high aggregate demand. Thus, overall profit variation from demand shocks is reduced compared to a scenario with spare capacity.
Traffic mix	The composition of traffic may determine an airport's elasticity of demand with respect to changes in aggregate demand. Certain types of users (e.g. long-haul passengers) may reveal a higher (lower) income elasticity than other types of users and imply higher (lower) Beta risk. However, more research is required to understand which demand segments systematically have higher or lower elasticities with respect to changes in aggregate demand.
Price elasticity of demand and market power	Under price cap regulation, strong competitive constraints may decrease Beta risk and increased market power may increase Beta risk. When the profit-maximising price falls below the level of the cap, airports facing more elastic demand find it easier to react and mitigate their profit erosion. However, the degree of market power only becomes relevant when airports charge prices below the cap during low demand outturn.

Source: Own illustration.

The assessment of Beta risk for non-listed airports typically requires ISAs to choose comparator airports that can serve as benchmarks for empirical evidence on the level of Beta risk. There are examples of ISAs conducting relative risk assessments considering some or all of the drivers of Beta risk that were identified in this article.

For example, the UK Civil Aviation Authority's (CAA) current thinking on the level of the WACC to be set for Heathrow in the next price review relies on a selection of Beta comparators that is based on considerations of relative differences in systematic risk. Specifically, the relevant consultant report assessed the differences in demand risk across peers using event studies of the 2009 economic downturn, passenger outturn elasticity with respect to GDP, and evidence on historical revenue variability (PwC, 2017).

Another example is the Irish CAR's 2019 Determination on the maximum levels of airport charges at Dublin Airport. The Commission has relied on an estimate of Beta risk that was derived from a weighted average of Beta estimates for comparator airports. The methodology attributed higher weights to peers that were more comparable to Dublin Airport in terms of the regulatory environment, business structure, and demand structure. Strongest emphasis was given to comparability of factors related regulation (Swiss Economics, 2019).[5]

Other recent regulatory precedent, e.g. the Italian Civil Aviation Authority's (ENAC) recent decision for Aeroporti di Roma (The Brattle Group, 2016), do not specify whether and how differences in risks were considered when comparator airports were selected

These examples illustrate that the methodologies European ISAs rely upon to assess differences in relative risk exposure and to select comparator airports currently are not uniform and are often not transparent. In a recent working paper that evaluates the implementation of the Directive on airport charges, the European Commission notes that the general remaining lack of transparency in how airport charges are determined in the EU contributes to the problem that some airports are able to set prices and terms that could not be achieved in a competitive market (EU Commission, 2019, p. 35).

It is possible that policy makers call for a more standardised approach to analyse airports' systematic risk in the future. The findings of this article could serve as the theoretical basis for economically sound recommendations to guide ISAs. My graphical framework allows to make clear predictions on how firm and market characteristics drive differences in Beta risk across airports. For many of them, there exist natural indicators that can help to categorise airports. For example, the length of the regulatory period over which a price cap is set may serve to distinguish between airports with relatively high Beta risk induced by regulation and airports with relatively low Beta risk induced by regulation. For other factors, such as the scope of the regulatory perimeter, reliable indicators that may effectively and accurately differentiate between various levels of risk exposure would still have to be defined.

Also, my framework currently does not allow to draw conclusions on the relative importance of risk drivers. Further research may aim to analyse which firm and market characteristics are of particular importance and whether other firm and market characteristics could be neglected in practice due to their limited impact in comparison.

Finally, firm and market characteristics are not the only drivers of systematic risk. Financial gearing is one example that has been identified as another key determinant. There may exist more sources of systematic risk unrelated to airports' characteristics and market environment. Further research on such alternative Beta drivers may be useful to ensure that the choice of adequate comparator airports is based on a comprehensive understanding of all factors that determine differences in systematic risk across airports.

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[5] For the sake of transparency, I disclose that I was involved in CAR's recent work on Dublin Airport's cost of capital in connection with its 2019 Determination of passenger tariffs, including in workstreams related to relative risk assessments of comparator airports.

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