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Does economic regulation improve efficiency? The case of airports

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ABSTRACT

Over the past 30 years, regulatory reforms have been introduced to enhance airport efficiency compared to traditional rate-of-return regulation. But have these reforms succeeded? We survey research on the impact of airport regulatory frameworks on technical, cost and allocative efficiency, addressing methodological challenges and identifying gaps for future study. We find that approaches such as total factor productivity, stochastic frontier analysis and data envelopment analysis are useful for assessing the effects of regulation, but many studies miss salient inputs and outputs, particularly in measuring capital. In second stage analyses, governance related variables, such as ownership structure, competition and regulatory design, are often overlooked. Most studies conclude that regulation improves airport efficiency, with dual-till price-caps and light-handed regulation being the more effective. However, light-handed regulation fails to reduce aeronautical charges and there is no consensus on which regulatory model achieves lower charges. Finally, allocative efficiency through peak pricing and slot trading remains unexplored.

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1. Introduction

The regulation of public utilities enhances welfare by addressing market failures such as the exploitation of market power enjoyed by natural monopolies. In markets with cost subadditivity, a single provider may be efficient but economic regulation is needed to prevent monopolistic pricing. Airports with significant market power could restrict output, charge higher prices and suffer from managerial slack due to weak incentives. In such cases, economic regulation attempts to address these failures and to improve both economic efficiency and welfare, provided the regulatory costs do not outweigh the welfare gains. Thus, the economic regulation of airports ought to be evaluated based on its impact on economic welfare. This study reviews the evolution and current state of airport regulation worldwide and the impact on airport efficiency. We highlight

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the advantages and limitations of the regulatory models implemented to date and provide guidelines for improving airport regulation. Additionally, we critique the methods commonly employed to assess airport regulation and highlight technical challenges that require attention in future studies. The review contributes to the literature by examining the policy implications of airport regulation, a subject of ongoing disputes between stakeholders. Finally, we discuss whether reforms undertaken to date have enhanced economic welfare based on evidence from benchmarking studies.

The significant fixed costs faced by airports pose challenges for efficiency estimation, as short-run marginal costs often fall below average costs when sufficient capacity is available. On the other hand, scarce capacity is commonly managed through a slot allocation system, which adds to the complexity of efficiency estimation. Capacity expansion requires substantial sunk costs and involves indivisibilities,[1] making such investments both critical and long-term. Airports function as multi-product firms, handling not only passengers and freight, but also commercial goods and services. Whilst traditionally publicly owned, many airports have undergone varying degrees of commercialisation and privatisation. Although most airports remain regulated, some have been deregulated in response to competitive market conditions (Forsyth et al., 2023).

The paper is organised as follows: Section 2 analyses airport regulatory reforms from a historical perspective. Section 3 explores productivity estimation methodologies. Section 4 reviews data required to estimate airport efficiency. Section 5 analyses the expected effects of regulation on efficiency, while Section 6 evaluates the literature on the impact of regulation on airport performance and charges. Conclusions, along with ongoing debates and potential future directions, are presented in Section 7.

2. Historical overview of airport regulatory reforms and institutions

Before the wave of privatisations initiated in the UK in 1987, most countries treated airports as public utilities of national importance. Although they were expected to cover their costs, they were not formally subject to economic regulation such as rate-of-return oversight. Formal regulatory frameworks were introduced only after airports were corporatised or privatised. Today, although many airports remain fully public entities, for example in the United States, partial privatisation can be found across Europe and fully privatised airports are prevalent in the United Kingdom and Australia. As a privatisation process is initiated, new regulatory institutions designed to prevent abuse of market power and to safeguard investors from excessive risk are frequently established. For these institutions to be effective, two conditions are important, namely minimal government intervention and protection against regulatory capture. Without these safeguards, governments may either set charges too low, hindering cost recovery, or too high because the government acts as a shareholder in the regulated enterprise (OECD/ITF, 2011). Airport regulatory institutions typically follow one of three distinct models. The first model involves a government regulator with an ownership stake in the regulated airport, which creates a dependency on the government and raises concerns about regulatory capture. Examples of this model are found in Belgium, Germany and Spain (Forsyth et al., 2021). In the second model, the regulator is a government entity with no ownership stake in the regulated airports, as seen in Austria and Hungary. The third model features a fully independent regulator, separate from both the government and the airport but accountable to the parliament, as practiced in the UK, Ireland, Italy and Australia (Adler et al., 2015). This section examines three regulatory approaches: rate-of-return regulation, incentive-based regulation often introduced during a privatisation process and light-handed regulation, the least intrusive form employed to date. Finally, we discuss two issues unique to airport regulation: two-sided tills and slot allocation.

2.1. Standard regulatory approaches

Under *rate-of-return regulation*, airport charges are set to achieve a specified rate-of-return on the asset base (Sherman, 1989). These charges are calculated based on accounting costs rather than opportunity costs (Doganis, 1992). The International Civil Aviation Organization (ICAO, 2012) continues to advocate for cost-based charging policies, recommending that airline users bear the full cost of providing airport services and essential ancillary services. Consequently, cost-based pricing has remained the standard mechanism, particularly for state-regulated public airports (Gillen & Niemeier, 2008). This form of regulation is applied at airports such as Brussels, Amsterdam, Zurich and major German airports (Forsyth et al., 2021).

Rate-of-return regulation has several significant drawbacks, including cost and allocative inefficiencies as well as high administrative costs (Liston, 1993). Cost inefficiency arises because firms with higher costs earn higher returns, thus the regulation incentivises cost padding. Over-capitalisation is another issue, arising when the permitted rate-of-return exceeds the cost of capital. This encourages firms to overuse capital relative to other inputs, a phenomenon known as the Averch and Johnson (1962) effect. Furthermore, this regulatory approach relies on historic costs, failing to account for shifts in demand, changes in supply conditions, and peaks in demand (Sherman, 1989).

Such drawbacks prompted economists to develop incentive-based regulation with *price-cap regulation* (also known as CPI-X or RPI-X regulation[2]) being the most prominent form. Airport price-cap regulation was first introduced in the UK in 1986 for airports owned by BAA, which were deemed to have significant market power. Subsequently, price-cap regulation was implemented worldwide, including Australia, Austria, France, Germany, Hungary, Italy, India, Ireland, Portugal and South Africa (Forsyth, 2008; Gillen & Niemeier, 2008). Price-cap regulation establishes a fixed price path for a firm over time, independent of its costs. Since prices are not adjusted downward when a firm reduces costs, the firm has a strong incentive to minimise expenses and retain the resulting profits from increased efficiency. A key advantage of RPI-X regulation over rate-of-return regulation is its focus on the price level rather than price structure, allowing firms to increase revenues and profits through more effective pricing strategies (Armstrong et al., 1994; Beesley & Littlechild, 1989). Rate-of-return regulation tends to encourage uniform price structures, whereas price-cap regulation incentivises firms to adjust their price structures to maximise profits. This flexibility can lead to the adoption of Ramsey pricing[3] and peak pricing strategies. However, not many public utilities have used this flexibility (Giulietti & Waddams Price, 2005).

Price-cap regulation has two potential disadvantages, namely under-investment and low service quality. Under-investment arises from the firm's concerns that regulators may behave opportunistically by lowering prices to marginal cost following a major investment. To mitigate under-investment, Helm (2009) proposes a regulated asset base (RAB), comprised of all assets necessary for the firm's operations. By allowing the RAB costs to be passed on to consumers, this approach incentivises regulated firms to undertake sufficient investments, resulting in adequate infrastructure development. With respect to service quality, monitoring is often applied alongside price-cap regulation to maintain adequate service levels. While Rovizzi and Thompson (1992) provide suggestions for effective service quality monitoring, Vogelsang (2002) finds little empirical evidence that price-cap regulation has led to lower service quality.

A third form of regulation is *light-handed regulation*, which involves monitoring and reviewing airport charges, costs, profits and quality of service. While prices are not directly controlled under this approach, explicit price regulation could be reintroduced if a regulatory review concludes that the airport is abusing its market power (Forsyth, 2008). Light-handed regulation is applied at Copenhagen, Gatwick and various airports in Australia and New Zealand (Forsyth et al., 2021).

Since explicit economic regulation incurs costs, light-handed regulation provides an alternative. It reduces the likelihood of opportunistic behaviour by the regulated firm, mitigates the risk of corruption and regulatory capture, minimises regulatory imperfections and limits regulatory influence on industry structure and conduct. A key feature of light-handed regulation is the negotiation of prices and service quality between producers and consumers, with arbitration as a fall-back. King and Maddock (1999) propose a negotiate–arbitrate model, showing that agreements are often reached during the negotiation phase, while Cowan (2007) argues that light-handed regulation yields higher welfare than rate-of-return or price-cap regulation. Theoretical modelling by Yang and Fu (2015) suggests that light-handed airport regulation may outperform price-caps in terms of social welfare.

Light-handed regulation has two potential disadvantages. The review–sanction approach may be ineffective in preventing airports from exploiting market power and could devolve into a form of cost-plus regulation were regulators to keep prices close to costs (Forsyth, 2008). To address these shortcomings, Forsyth (2008) and Littlechild (2012) propose a negotiate–arbitrate model to enhance light-handed airport regulation though these reforms have yet to be implemented.

2.2. Airport-specific regulation

Airport rate-of-return and incentive regulation follow either a dual-till or single-till approach. A dual-till regulates solely aeronautical costs, while a single-till extends the scope of regulation by covering both airside and landside commercial services. Under cost-based US regulation, airlines negotiate agreements with airports using either residual or compensatory mechanisms (Graham, 2023). The residual approach, which parallels the single-till, requires airlines to collectively cover the net operating costs of the airport after accounting for non-aeronautical revenues, effectively guaranteeing that the airport breaks even. Conversely, the compensatory approach mirrors a dual-till, whereby airlines pay pre-determined charges based on the costs of the specific facilities and services utilised, with the airport operator bearing the associated operational risks.

In principle, the scope of regulation should not be extended to commercial activities because they operate in contestable markets. At congested airports, a dual-till is considered preferable to single-till in order to ensure clear pricing signals, economic efficiency, efficient capacity allocation, congestion management and strong investment incentives (Kidokoro & Zhang, 2022). For non-congested airports, a single-till is preferred because aeronautical charges can be set at marginal cost, with deficits covered by commercial revenues (Czerny, 2006). On the other hand, there are strong arguments for a dual-till at non-congested airports. First, the dual-till approach enables Ramsey pricing to address financial deficits. Second, regulatory opportunism is less of a risk under dual-till. Third, single-till acts as a tax on commercial activities, reducing incentives for market development. At congested airports, a dual-till supports peak and off-peak pricing, whereas single-till distorts competition and increases scarcity rent for airlines. Consequently, Niemeier (2021) argues that dual-till is preferable regardless of airport congestion levels. Regulatory practice indicates that airports favour dual-till, whilst airlines prefer single-till (Czerny et al., 2016).

The second key aspect of airport-specific regulation is the slot allocation system. When capacity is scarce, airports or independent regulators manage demand based on the Worldwide Airport Slot Guidelines, except in the US where queuing and gate limitations primarily regulate excess demand. US airports could reduce their comparatively higher congestion levels by introducing congestion charges, but attempts to implement such measures have consistently failed. While slots help to coordinate flights and minimise delays, the process itself often creates challenges. The guidelines follow the grandfathering principle, allowing incumbent airlines to retain their slots in the next period provided they used at least 80% in the previous period. Adler and Yazhemsky (2018) argue that EU slot limitations are excessively restrictive, reducing consumer and producer surplus more than necessary. Czerny et al. (2008) criticise the grandfathering approach for failing to allocate scarce slots to airlines with the highest willingness to pay. They recommend secondary trading, practised at a few major UK airports, and auctions which have never been implemented except for a short time for domestic flights at two Chinese airports (Cardadeiro & Gata, 2022).

In the short-run, allocative efficiency[4] requires effective slot allocation through secondary trading and/or auctions, alongside per-movement airport charges. Otherwise, small aircraft are under-charged and marginal congestion costs fail to reflect slot values (Forsyth & Niemeier, 2008a, 2008b). Evidence suggests that many EU airports fall short of this standard (Forsyth et al., 2023). Although the EU Commission has attempted to reform these rules, it has not yet succeeded. At capacity-constrained airports, lowering charges through regulation merely increases airline slot rents, without improving efficiency or welfare. In the long-run, slot allocation disrupts the link between pricing and investment because airlines capture the scarcity rents which discourages additional capacity investment. Consequently, slots create allocative inefficiencies which reduce movements, passenger throughput and connectivity in the short-run, while hindering airport expansion in the long-run.

3. Productivity estimation methodologies

Before examining airport performance, which is the focus of Section 6, first we distinguish between productivity and efficiency. Productivity is defined as the ratio of an aggregate measure of outputs to an aggregate measure of inputs. An airport can be technically efficient without achieving maximum productivity if it operates at a sub-optimal scale on the production frontier. Additionally, productivity can change over time due to technological advancements. Improved productivity therefore can be attributed to efficiency gains, economies of scale or technical progress (Coelli et al., 2005).

When analysing airport efficiency, we distinguish between technical, allocative and cost efficiencies. *Technical efficiency* refers to the ability to produce maximum output given a set of inputs or to produce a specific level of output with minimum input usage, given the feasible production possibility set. *Input-oriented allocative efficiency* refers to the ability to select the optimal mix of input quantities such that the ratio of input prices equals the ratio of their marginal products. *Cost efficiency* occurs when an airport produces a given output at the minimum possible cost, based on the relevant input prices, thus combining both technical and input-oriented allocative efficiencies. *Output-oriented allocative efficiency* refers to the ability to choose an optimal combination of outputs such that the ratio of output prices equals the ratio of marginal costs (Coelli et al., 2003). At airports with spare capacity, Ramsey pricing maximises output-oriented allocative efficiency. At airports with excess demand, efficiency is achieved through peak pricing or the use of slots. However, peak pricing is rarely implemented, with slot allocation being the more commonly used approach. Curi et al. (2011) also apply the concept of *financial efficiency* which is equivalent to technical efficiency but based on financial inputs and outputs. Analyses are focused on the short-term when some factors of production are fixed, or the long-term when all factors are deemed variable.

The three main methodologies used to measure airport productivity and efficiency are total factor productivity (TFP), stochastic factor analysis (SFA) based on econometrics and data envelopment analysis (DEA) based on mathematical programming. All three methodologies have been applied to examine the impact of regulation on airport performance. We briefly discuss each methodology and then compare and contrast the approaches. We note that partial productivity measures have been used in the economic regulation of a few airports (e.g. Dublin) (Forsyth et al., 2023). However, we focus on methodologies modelling entire production processes.

TFP measures the ratio of aggregate output to aggregate input when multiple inputs and outputs are involved. A change in TFP is defined as the difference in output levels between two periods, assuming maximum output is produced with the given inputs under the reference technology. TFP is an aggregate productivity measure that can be estimated using parametric approaches, assuming production functions, or non-parametric index number approaches. Index-number-based TFP computations assume that a firm exhibits technical and allocative efficiency. To facilitate comparisons across multiple firms, index numbers are derived such that they are transitive (Coelli et al., 2005).

Estimating a firm's production function and operational efficiency is useful for improving performance at both the firm and aggregate levels, as well as for implementing economic regulation. A widely-used framework for such estimation is SFA, where the output is modelled as the sum of three terms. The first term estimates the underlying production function, capturing the relationship between inputs and outputs. The second term is an asymmetrically distributed, random effects component that reflects the efficiency of the individual firm. The third term is a symmetrically distributed, random error component, which accounts for various factors such as omitted variables, measurement errors in inputs and approximation errors in the production function. SFA was initially introduced as a cross-sectional model by Aigner et al. (1977) and Meeusen and van Den Broeck (1977) independently. Subsequent methodological advancements include panel data SFA models, notably Battese and Coelli's (1995) time-varying inefficiency model and Greene's (2005) true fixed and random effects models, which have been widely adopted in efficiency and productivity research. For those interested in an in-depth review of SFA, see Kumbhakar and Lovell (2003), and for panel data applications, the survey of Kumbhakar et al. (2020).

DEA was introduced by Charnes et al. (1978) under the assumption of constant returns-to-scale and later extended by Banker et al. (1984) to include variable returns-to-scale. This non-parametric method for frontier estimation measures the relative efficiency of firms, often denoted as decision-making units (DMU), based on multiple inputs and outputs. DEA compares each DMU to an efficient subset of observations with similar output to input ratios, assuming neither a specific functional form for the production function or the inefficiency distribution. DEA solves a linear programme per DMU and the weights assigned to each linear aggregation are the decision variables of the mathematical programme. The objective is to assign weights (i.e. priorities) that showcase the DMU in the most favourable light while ensuring no other DMU receives more than 100% efficiency with the same set of weights. Consequently, the analysis identifies a Pareto frontier, with efficient DMUs forming the boundary of the input-output variable space. For an in-depth review of DEA, see Emrouznejad and Yang (2018).

Index-number TFP, SFA and DEA have been used quite extensively to measure the performance of airports. While SFA is a parametric method that accounts for statistical noise, index-number TFP and DEA do not have these attributes. Both DEA and SFA estimate technical and allocative efficiency, technical change and scale effects, whereas index-number TFP cannot be used for these purposes. However, all three methods are used to estimate changes in total factor productivity over time. Index-number TFP relies on time-series data, while DEA and SFA primarily use cross-sectional and panel datasets. The three models differ not only in their research approach, assumptions and treatment of inefficiency and noise, but also in their data requirements. Index-number TFP requires input and output prices along with input and output quantities whereas DEA and SFA only require input and output quantities to estimate efficiency. The main advantage of index-number TFP is its relatively minimal data requirements, as theoretically even two data points would be sufficient. In contrast, DEA and SFA require larger datasets, either covering multiple firms in a single period or one firm over multiple periods. DEA and SFA offer several advantages over index-number TFP. They do not require price information, do not assume firms operate on the technical, cost or allocative efficiency frontier and do not assume firms are cost minimisers or revenue maximisers. Additionally, when DEA and SFA are used to estimate total factor productivity, the index can be decomposed into technical change and allocative efficiency over time. Comparing DEA and SFA, the key advantage of SFA is that it accounts for statistical noise and can be used to conduct hypothesis testing. In contrast, DEA does not require the specification of a distributional form for the inefficiency term or a functional form for the production or cost frontier (Coelli et al., 2005). For further information on comparing these methods, see Bogetoft and Otto (2010).

4. Datasets to estimate airport efficiency

This section examines the inputs and outputs commonly collected to study airport efficiency (see Appendix). We acknowledge that variable selection in frontier analysis is inherently challenging due to data limitations, often requiring researchers to use proxy variables. Despite these methodological constraints, the studies contribute to our understanding of regulation and their impact on airport efficiency. The input variables are generally derived from the KLEMS model (Jorgenson et al., 1987), namely capital, labour, energy, materials and supplies. While data for some variables, such as labour, are relatively easy to collect and of good quality, capital poses greater challenges. Capital (K) is often measured by the capital stock (Bottasso & Conti, 2012; See & Li, 2015), but these studies are limited to single-country analyses. For cross-country comparisons, physical proxies are used because differences in depreciation methods make direct comparisons of capital stock unreliable. Common proxies include declared runway capacity, airport area, number of runways, apron area and terminal size (Adler et al., 2015; Adler & Liebert, 2014; Assaf et al., 2014; Assaf & Gillen, 2012; Curi et al., 2011). Whilst capital stock enables an efficiency analysis to identify whether regulation leads to the Averch-Johnson effect, gold plating and cost padding, proxies for capital may be less suitable. A preferable alternative is the perpetual inventory method (used by See & Li, 2015), but it is highly data-intensive, requiring detailed information on capital stock dating back to the airport's inception. In the case of outputs, aeronautical activities and non-aeronautical revenues should be considered to avoid bias. Non-aeronautical revenues are an important income source, particularly at hub airports where more than 50% of the total revenues stem from commercial concessions (Graham, 2023).

Failure to account for all necessary inputs and outputs when measuring technical, cost and allocative efficiency will likely impact the accuracy of the results. For example, Assaf (2010) did not include the price of materials or non-aeronautical revenues in his study of cost efficiency of Australian airports, although commercial activities constitute a large share of revenues and strategies to develop this business vary significantly across airports. Similarly, Assaf et al. (2012) analysed UK airport cost efficiency without distinguishing between aeronautical and commercial revenues. This omission is of concern because airlines have criticised airport regulators for incentivising efficiency improvements in commercial activities at the expense of aeronautical operations. Other studies have overlooked capital (e.g. Randrianarisoa et al., 2015) and cargo handled (e.g. Assaf et al., 2014; Assaf & Gillen, 2012; Oum et al., 2004). Additionally, proxies used for inputs and outputs may not adequately represent the airport production process. For example, Karanki and Lim (2020) used work load units as an output, which is not a good indicator of the volume of passengers and cargo handled because they differ in their resource requirements and revenue contributions (Liebert & Niemeier, 2013).

It is important to consider whether the impact of regulation on efficiency can be examined separately from other factors such as ownership and competition. Some studies, e.g. Adler and Liebert (2014) and Randrianarisoa et al. (2015), isolate the effects of ownership and competition from regulation, providing the opportunity to understand the role of each factor. In contrast, Assaf and Gillen (2012) and Assaf et al. (2014) assess the combined effects of ownership and regulation on efficiency without accounting for the impact of competition. A more nuanced analysis of regulation becomes possible when these factors are considered separately. Niemeier (2021) underscores the challenges associated with failing to make these distinctions and emphasises their importance in public policy debates.

5. Expected effects of airport regulation on components of efficiency

Many countries have transitioned from rate-of-return regulation to either incentive-based or light-handed regulation and have also reformed their regulatory institutions towards the model of an independent regulator. This section evaluates the impact of these regulatory changes on airport efficiency.

In Table 1, we present the potential impact of market structure and regulatory environment on technical, cost and allocative efficiency according to the theory. The final column specifies the literature that has answered such questions with respect to airports. Many of these conjectures have yet to be proven and remain directions for future research. Rows 1–3 of Table 1 summarise the likely impact of market structures and regulatory environments on efficiency. In a monopoly setting, firms maximise profits by limiting output and increasing prices. This behaviour may prevent full exploitation of economies of scale, affecting both technical and cost efficiency negatively. However, this is not always the case for public airports, which may prioritise welfare maximisation over profit maximisation. Monopolies may also be cost inefficient due to managerial slack, a phenomenon known as Leibenstein X-inefficiency. Consequently, natural monopolies require economic regulation to address these inefficiencies. In contrast, when competition constrains market power, regulation could distort technical and cost efficiency hence may not be necessary.

Rate-of-return regulation (rows 4–8 of Table 1) is expected to lower charges and increase output compared to an unregulated monopolistic market, leading to improvements in technical and cost efficiency. However, these benefits may be offset by practices such as cost padding and the Averch-Johnson effect. At congested airports, this type of regulation may further incentivise peak demand to justify capital-intensive expansions. Such behaviour negatively impacts output-oriented allocative efficiency, though a slot allocation system may help mitigate some of these effects. The U.S. is an interesting case study because of their unique process of regulating their fully publicly-owned airports. Even though the regulation is rate-of-return, the compensatory and residual use agreements akin to dual- or single-till respectively might mean that one form may be more efficiency enhancing than the other.

Incentive-based regulation (rows 9–15 of Table 1), such as price caps, is considered more effective than rate-of-return regulation at promoting cost and allocative efficiency. However, without oversight of the regulated asset base (RAB), this form of regulation may lead to under-investment and lower service quality. At uncongested airports, incentive-based regulation should lower costs. These cost savings lead initially to an increase of airport profits and finally to a lower level of charges. As airports have traditionally used weight-based charges, which is an imperfect application of Ramsey pricing, incentive regulation could lead to less imperfect forms with relatively small gains in welfare. Larger welfare gains are expected from incentive regulation at congested airports. Price caps should encourage efficient pricing structures, such as peak or congestion pricing. When capacity is managed through slots, price-caps should incentivise

Table 1. The theoretical impact of market structure and regulatory environment on efficiency and the empirical evidence.

Market structure/ Regulatory environment	Row	Theoretical hypotheses	Theoretical impact on: Technical and cost efficiency	Theoretical impact on: Allocative efficiency	Empirical publications proving theoretical hypotheses
Monopoly	1	Restriction of output and unexploited economies of scale	–		Adler and Liebert (2014)
	2	*X*-inefficiency if firm not profit-maximising	-		Adler and Liebert (2014)
Competitive Market	3	Regulation distorts efficiency	-		Adler and Liebert (2014)
Rate-of-Return Regulation	4	Lower charges and higher output compared to monopolistic market without regulation	+		Bilotkach et al. (2012), Assaf and Gillen (2012)
	5	Congested facilities lack incentives to set peak prices	-	-	***Further research needed***
	6	Excess of capital leads to Averch-Johnson effect, gold plating and cost padding	-		Oum et al. (2004), ***but further research needed***
Single-Till Rate-of-Return Regulation	7	Restricts potentially competitive commercial activities	-		***Further research needed***
Dual-Till Rate-of-Return Regulation	8	Higher charges decrease output compared to single-till rate-of-return regulation	-		***Further research needed***
Price-Cap Regulation	9	Peak pricing incentivised		+	***Further research needed***
	10	Cost efficiency encouraged	+		Oum et al. (2004), Curi (2011), Assaf et al. (2012), Adler and Liebert (2014), Cambini and Congiu (2022)
	11	Under-investment causes deterioration in quality of service	-		Oum et al. (2004), ***but further research needed***
Single-Till Price-Cap Regulation	12	Leads to lower caps compared to dual-till	+		Bilotkach et al. (2012)
	13	Creates weak incentives to earn commercial revenues	-		***Further research needed***
Dual-Till Price-Cap Regulation	14	Lower charges & higher passenger throughput, compared to rate-of-return	+		Adler and Liebert (2014)
	15	Commercial revenues are unregulated	+		Adler and Liebert (2014)
Light-Handed Regulation	16	With credible threat and arbitration mechanism, cost efficiency and output-oriented allocative efficiency are encouraged	+	+	Assaf (2010), ***but more research needed***
	17	Flexible with low regulatory burden	+		***Further research needed***
	18	Incentives for Ramsey pricing at uncongested airports and peak pricing at congested airports		+	***Further research needed***
Independent Regulator	19	Provides long-term commitment to immobile and specialised investment	+	+	***Further research needed***
	20	Prevents costs and charges from increasing above optimal level	+		Cambini and Congiu (2022)

airports to shift from weight-based to per-movement charges, which better reflect resource usage and can contribute to improved efficiency.

Under light-handed regulation (rows 16–18 of Table 1), theory suggests that a congested, profit-maximising airport will adopt peak pricing. However, the regulation does not guarantee such behaviour in practice because political, institutional and strategic considerations may influence airport decisions. At uncongested airports, the benefits of improved price structures remain limited due to the traditional reliance on weight-based charges. In terms of allocative efficiency, light-handed regulation operates similarly to incentive-based regulation, with both being preferable to rate-of-return regulation. Moreover, light-handed regulation is more flexible with lower regulatory burden, which may encourage cost efficiency provided there is a credible threat of re-regulation and an arbitration mechanism to resolve disputes between airports and airlines. However, the positive effects of light-handed regulation on efficiency may be limited if the regulatory mechanism merely monitors and there is limited competition, as observed in Australia.

The charging scheme may also influence efficiency outcomes significantly. Under single-till rate-of-return regulation, charges are lower and output is higher compared to dual-till, leading to improvements in technical and cost efficiency. However, airports have little incentive to be innovative or explore alternative commercial revenues because the single-till approach effectively taxes commercial revenues, which in turn hinders technical efficiency. In contrast, the dual-till approach regulates aeronautical revenues, targeting only those activities with monopolistic characteristics. This framework incentivises airport management to develop non-aeronautical revenue streams, supporting both technical efficiency and business diversification.

Independent regulators (rows 19–20 of Table 1) are less susceptible to regulatory capture and provide long-term stability for immobile, specialised investments, benefiting both cost and allocative efficiency. Furthermore, an independent regulator encourages airports to set charges at optimal levels and to focus on cost minimisation, further enhancing cost efficiency. In summation, despite theoretical insights, the impact of regulation remains under-explored in the transportation literature (see Table 1), hence further empirical research is necessary to ensure that regulatory frameworks align with efficiency goals.

6. The impact of regulation on airport performance and charges

Figure 1 provides an overview of the 17 studies conducted on airport regulation, charges and efficiency which have been summarised in the appendix. The studies applying regression utilised SURE and 3SLS to estimate variable cost functions and difference-in-differences to estimate average cost functions. In the charges literature, pricing equations have been studied using IV-2SLS, system GMM dynamic panel data models and difference-in-differences. One study estimates a revenue function using a panel-data random effects model. The remaining studies apply the efficiency methodologies described in Section 3. According to the regional classification, most studies focus on Europe, where many forms of regulation have been employed. The studies on Australia analyse light-handed regulation and only one study has included the Asia Pacific region. The two themes in the literature are the studies on charges and the efficiency and productivity

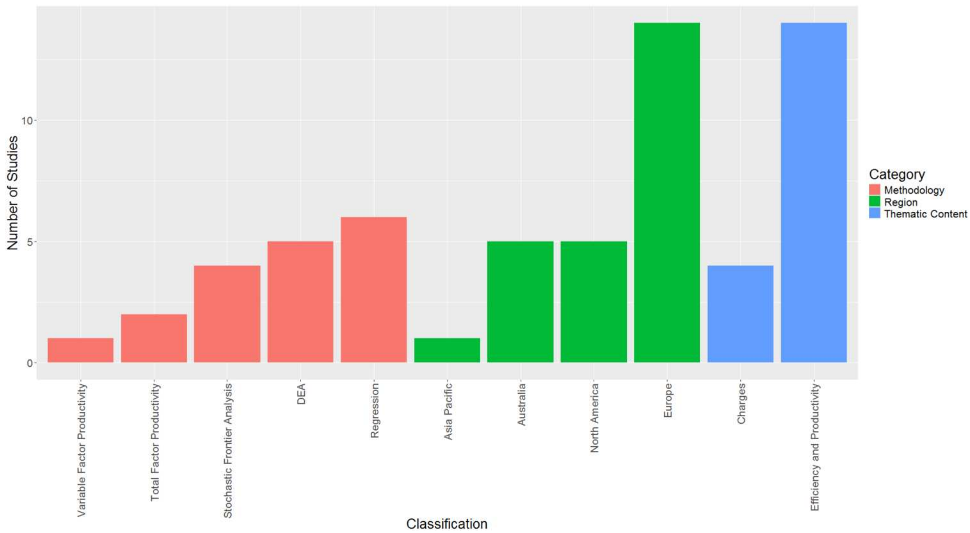

Figure 1. Overview of studies by classification.

studies. The charges literature uses pricing and revenue equations estimated using all classified methodologies.

Determining the most suitable regulatory approach for airports is challenging, hence the variety of approaches that have been implemented globally. Ten efficiency studies report positive effects of regulation on efficiency, while three find negative effects and one detects no significant effect. Among the four studies examining the effects of regulation on airport charges, all identify a positive impact with some caveats. This section provides a detailed discussion of the findings.

Oum et al. (2004) is the first study to identify a positive relationship between regulation and airport efficiency. Analysing airports in Asia Pacific, North America and Europe during 1999–2000, they find that capital input productivity is highest under single-till price-cap, followed by dual-till price-cap compared to single-till rate-of-return regulation. In terms of total factor productivity, dual-till price-caps lead to higher productivity than single-till rate-of-return regulation.

Adler and Liebert (2014) analyse the combined effects of competition, ownership form and regulation on cost efficiency and prices, using an unbalanced panel of European and Australian airports from 1998 to 2007. Their findings suggest that cost-plus regulation creates disincentives for efficiency, whereas dual-till incentive-regulated airports are more cost efficient than their single-till incentive-regulated counterparts. In a competitive environment, both fully public and fully private airports operate 21% more cost-efficiently than their regulated counterparts. However, aeronautical prices at unregulated private airports are 11% higher than those at unregulated public airports. In addition, Adler and Liebert conclude that fully private, dual-till price-cap regulated airports are the most relatively cost efficient in weakly competitive markets. Adler et al. (2015) analyse the effects of cost-based and incentive regulation on the short-term technical efficiency of European and Australian airports from 1990 to 2010, employing a two-stage benchmarking and regression methodology. They find that incentive regulation improves productive efficiency compared to cost-plus regulation. Light-handed regulation increases efficiency by 9%, hybrid price-caps by 12% and pure price-caps by 19% relative to cost-plus regulation. However, the study does not find a significant link between the independence of the regulator and efficiency. Moreover, both papers use declared runway capacity as a proxy for capital, which limits insights into the Averch-Johnson effect.

Out of eight country-specific studies, seven report that regulation positively impacts airport performance. Assaf et al. (2012) analyse the cost efficiency of UK airports between 1998 and 2008, finding that regulated airports were 10% more cost-efficient than unregulated airports facing competition. However, this study does not differentiate between aeronautical and commercial revenues, which prevents an analysis of the relative importance of each revenue stream. Bottasso and Conti (2012) estimate the short- and long-run translog variable cost functions of UK airports from 1994 to 2005. Their results indicate an annual technical improvement of around 2% but also identify over-capitalisation at larger airports. While their findings suggest a positive impact of regulation, the study does not explicitly measure the impact of regulation on costs, leaving the magnitude of the impact of regulation uncertain. Curi et al. (2011) analyse the operational and financial efficiency of Italian airports from 2000 to 2004, measuring technical efficiency based on financial inputs and outputs. The results suggest a net increase in efficiency following the introduction of dual-till price-caps. However, the capital inputs are based on the number of runways and apron size, which prevents detection of the Averch-Johnson effect. Moreover, commercial revenues were excluded and the impact of regulation on efficiency was not explicitly estimated, limiting potential insights. Cambini and Congiu (2022) apply a difference-in-differences framework to assess the effect of dual-till price-cap regulation introduced in Italy, alongside the creation of an independent transport regulation authority. Their findings suggest that the average cost efficiency of the treated airports improved significantly. In the context of light-handed regulation, Assaf (2010) investigates the cost efficiency of Australian airports from 2002 to 2007, approximately five years after their privatisation. The study finds increasing cost efficiency over time, resulting from the privatisation process and implementation of light-handed regulation. However, the study does not include earlier years when Australian airports were subject to price-caps, leaving a gap in the comparative assessment of these two regulatory approaches. Moreover, the impact of light-handed regulation on cost efficiency is not explicitly measured. Karanki and Lim (2020) analyse US airports from 2009 to 2016 and find that airports operating under compensatory or hybrid financial agreements are between 18% and 23% more technically efficient than those operating under residual agreements. Valdes et al. (2024) analyse concessioned airports in Mexico from 2006 to 2019, finding that dual-till revenue caps increase productive efficiency during the regulated periods. However, efficiency declines during the resetting of caps when forecasted demand falls short of covering allowed operational and capital expenditures. While regulation has positive effects, they argue that homogeneous expectations and strategic behaviour by airports expose weaknesses in the regulatory framework.

Turning to the studies with negative results, Assaf and Gillen (2012) estimate the combined impact of governance form and regulation on the productive efficiency of airports in Europe, North America and Australia between 2003 and 2008. Their results suggest that fully private airports under light-handed regulation and unregulated, government-owned airports are the most technically efficient. In contrast, government-owned airports subject to cost-based, single-till regulation are the least efficient. Fully private airports with light-handed regulation and unregulated, government-owned airports are 22% and 24% more efficient, respectively, than cost-based single-till regulated government-owned airports. They further argue that the more restrictive the form of regulation, the lower the productive efficiency, regardless of ownership form. Assaf et al. (2014) expand on this analysis, investigating the joint impact of ownership and regulation on both short- and long-run technical and allocative efficiency using the same dataset. They find that economic regulation reduces technical efficiency in the short-run, except in the case of privately owned airports under light-handed regulation in Australia and New Zealand. For other combinations of ownership and regulation, short-run technical inefficiency is higher by 4% to 250%. Regardless of governance type, they argue that removing single-till price-cap regulation would always improve economic efficiency, with the greatest gains expected for fully or partially publicly owned airports. However, both studies use the number of runways and terminal size as proxies for capital inputs, which limits the ability to assess over-investment. Additionally, neither study measures the impact of competition on efficiency, although both recommend deregulation. See and Li (2015) is the only country-specific study to report negative effects of regulation. They estimate the impact of size, regulation and ownership form on the total factor productivity of UK airports from 2001 to 2009. Their results show that regulated airports experienced lower TFP growth rates compared to unregulated airports, with the difference in growth rates being approximately 2.5%.

It seems that the studies present contradictory findings, with regulation leading to both positive and negative effects. These differences are difficult to reconcile due to variations in methodologies, country focus and time periods. While Assaf and Gillen (2012) and Assaf et al. (2014) use the same database as Oum et al. (2004), they analyse different time periods for the same set of airports. Since benchmarking is always relative, variations in sample composition can significantly alter the results.

However, a closer examination reveals broad agreement on key aspects of regulation. Assaf and Gillen (2012) and Assaf et al. (2014) argue that economic regulation reduces technical efficiency and limits output, particularly under government ownership, and therefore recommend full privatisation and deregulation. Unless the combined effect of ownership and regulation is entirely driven by ownership,[5] these studies suggest that transitioning from rate-of-return to incentive-based regulation has a positive impact. Overall, these findings align with Oum et al. (2004) and Adler et al. (2015) regarding the benefits of adopting lighter regulatory approaches.

With respect to airport charges, the critical question is whether airports have lowered their charges as a result of efficiency gains. Only four studies have addressed this policy-relevant issue, all of which agree on the positive effects of regulation but differ significantly regarding the impact of regulatory reforms in terms of incentives and scope. None of these studies account for discounts on published charges which are growing in importance, hence this is an avenue for further research. Bel and Fageda (2010) and Conti et al. (2019) utilise published charges for representative aircraft, while Bilotkach et al. (2012) and Adler and Liebert (2014) estimate charges based on the aeronautical revenues collected. Both approaches have strengths and limitations. On the one hand, published charges do not account for discounts offered to airlines, which may reduce charges below the regulated maximum. On the other hand, revenue estimations require reliable data.

Bel and Fageda (2010) conclude that transitioning from cost-based to price-cap regulation does not substantially influence charges, a finding supported by Bilotkach et al. (2012). Both studies explain their results by referencing Starkie (2004), arguing that he suggested price caps and cost-based regulation are equivalent. However, this is a misinterpretation because Starkie does not dispute that price caps set stronger incentives than cost-based regulation rather presents evidence that price-caps have not led to underinvestment, citing the expansion of Stansted Airport as an example.[6] Bel and Fageda (2010) find that neither single- nor dual-till regulated airports substantially influence charges. However, Bilotkach et al. (2012) find that single-till airports tend to set lower charges, which they attribute to cross-subsidisation.

The efficiency estimates and conclusions of Adler and Liebert (2014) contrast with those of Bel and Fageda (2010) and Bilotkach et al. (2012). Their results suggest that both the form and scope of regulation significantly influence the level of aeronautical charges. Uncongested, price-capped airports operating under dual-till regulation set lower aeronautical charges than single-till, cost-based regulated airports, indicating that efficiency gains are passed on to airlines. However, Adler and Liebert (2014) also identify important exceptions. Although both unregulated public and private airports may operate equally efficiently in competitive markets, private airports tend to set higher charges compared to their public counterparts. Furthermore, congested, single-till, incentive-regulated airports charge lower aeronautical prices than their dual-till regulated counterparts. A notable example is London Heathrow, where the dominance of the single-till principle reduces charges thereby increasing slot rents rather than consumer surplus. Conti et al. (2019) assess the effects of the EU Airport Charges Directive on aeronautical charges and find that the shift towards incentive-based regulation under an independent regulator has led to a reduction in charges over time, consistent with the findings of Adler and Liebert (2014). However, Conti et al. do not examine variations in the form and scope of airport regulation across different institutional settings, leaving room for further research.

7. Conclusions and future directions

A comprehensive review of the literature on the economic regulation of airports reveals key insights into the connections between efficiency and regulation, however we also highlight significant gaps and unresolved questions. While existing studies provide a strong foundation, future research ought to broaden its analysis from a focus on cost efficiency to a wider consideration of economic welfare. Based on our review, we have synthesised the most pressing research gaps below and propose a forward-looking agenda to address them in Table 2.

First, regulation enhances economic welfare by increasing technical and cost efficiency and lowering charges, regardless of regulatory form. However, regulating airports that operate in competing markets can reduce efficiency. Consequently, research focused on developing precise measures of competition may help to explain airport competition effects. Second, incentive-based regulation sets stronger incentives for cost efficiency

Table 2. A research agenda.

Theme	Open Research Questions
1. ***Governance & Market Structure***	
Institutional Framework	What is the impact of regulatory independence on airport performance and investment decisions?
Market Competition	How does the degree of airport and airline competition influence airport efficiency and charges?
2. Regulatory Design	
Price & Revenue Regulation	How do single, dual, and mixed till regulatory models impact aeronautical charges and the performance of commercial activities?
Investment Regulation	To what extent does the Regulatory Asset Base (RAB) model incentivise optimal investment and service quality? What are the primary drivers of excessive capital spending?
Alternative Regulation	What is the effect of light-handed regulation on airport efficiency, charges and overall welfare compared to stronger regulatory models?
3. ***Capacity Management***	
Capacity & Congestion	How do administrative slot limits affect operational efficiency and mitigate congestion?
	What are the comparative effects on efficiency of non-administrative capacity management versus slot-controlled systems?
Pricing & Congestion	What is the impact of peak-load pricing on demand management and airport efficiency?
4. ***Economic Welfare & Outcomes***	
Distribution of Gains	To what extent are airport efficiency gains passed on to airlines and passengers through lower charges and improved services?

than rate-of-return regulation. While price-cap regulation is widely considered more effective than rate-of-return regulation, further research is needed to identify the specific sources of these efficiency gains. Third, dual-till price-cap regulation is preferred over single-till rate-of-return or price-cap regulation because it supports the development of commercial activities while ensuring that efficiency gains are passed on to airlines through lower charges. However, additional research is needed to examine the impact of dual- and single-till regulation on commercial activities and charges, including the potential benefits of hybrid-till models. Fourth, there is a significant research gap concerning allocative efficiency and pricing in the airport performance literature, which predominantly focuses on cost efficiency. An exception is Adler and Liebert (2014), who find that dual-till price-caps incentivise cost reductions, with the savings passed on to airlines which contradicts Bilotkach et al. (2012) and Bel and Fageda (2010), although methodological limitations may explain these discrepancies. Future research should explore the effects of regulation on charge levels, particularly under light-handed regulation, where evidence suggests that high charge levels persist despite cost efficiency. In addition, research should address the structure of charges, in particular with respect to peak pricing and slot allocation.

Two key aspects that warrant further investigation include slot capacity limits and the comparison between slot allocation and queuing. Pels et al. (2003) find that slot-coordinated European airports are more technically efficient than those without slot-coordination, likely due to higher capacity utilisation.[7] This highlights the trade-off between slot capacity limits and congestion levels. Adler and Liebert (2014) find that delays lead to lower cost efficiency, while runway utilisation above 90% enhances cost efficiency.[8] Moreover, Adler and Yazhemsky (2018) find that the benefits of adding a slot during peak-periods at congested European airports outweigh the congestion and delay costs incurred. These findings underscore the need for further analysis to determine optimal slot capacity limits and their implications for airport efficiency. Regarding the comparison between slot allocation and queuing, Jacquillat and Odoni (2018) conclude that slot allocation is a more effective method for managing congestion. A benchmark of US airports, which rely on queuing, with airports using slot allocation, could provide useful insights into their relative performance. A further step would be to examine whether congested, price-capped airports are incentivised to adopt peak pricing and the impact of such pricing on their efficiency. Expanding these lines of research might deepen our understanding of the relationships between regulatory approaches, pricing strategies and airport performance.

Airport capital investment requirements remain under-explored in the literature, largely due to challenges with measurement. Many studies rely on proxies for capital, which hinders an analysis of the Averch-Johnson effect. Additionally, price-cap regulation may contribute to under-investment and lower quality of service (Oum et al., 2004). For this to be analysed, quality of service must be included as an output measure (Merkert & Assaf, 2015). To mitigate under-investment concerns, many European airports have adopted price-caps linked to a regulated asset base (RAB). This practice provides incentives for investment while aligning returns with regulatory expectations. Comparative analyses of RAB-based price-cap regulation and light-handed regulation might offer insights into their relative effectiveness in maintaining service quality.

There is an ongoing debate about whether price-cap or light-handed regulation are the more effective form of incentive regulation. Assaf (2010) finds that light-handed regulation enhances cost efficiency at Australian airports. However, Assaf's analysis does not directly compare the two approaches. Further research should examine whether the negotiate/arbitrate or review/sanction approaches, in conjunction with price-cap or light-handed regulation, yields better outcomes. The research could be extended beyond Australia to include the relatively few European airports operating under light-handed regulation, thus providing a broader understanding of the effectiveness of different regulatory approaches for airports in non-competitive markets.

Whilst Adler et al. (2015) find no significant efficiency effects associated with an independent regulator, Cambini and Congiu (2022) show that the independent Italian transport regulation authority has achieved significantly lower average costs. Given that many countries now have independent airport regulators and there is renewed interest in the European Union in promoting independent oversight, further research is needed to assess their impact.

All these issues present interesting avenues for future research with significant policy implications and are summarised in Table 2. Further analysis of the global south could also contribute to the debate on optimal policies. Valdes et al. (2024) is the only study on a developing country to date. India adopted price-caps in 2008 but its effects have yet to be estimated. Furthermore, except for the works of Cambini and Congiu (2022) in Italy and Valdes et al. (2024) in Mexico, most existing studies focus on periods prior to 2009, despite ongoing reforms leading to regulatory changes in many additional countries. Expanding the temporal and geographical scope might provide a more comprehensive understanding of the regulatory impacts.

Notes

1. The nature of airport investments is subject to debate. The traditional view (Forsyth et al., 2023) holds that airport investments are long-term and relation-specific thus they only

retain value if airlines continue to use the facilities over their lifespan, otherwise the costs are sunk due to limited alternative use. Airport investments are also considered lumpy because major expansions, such as runways and terminals, are usually undertaken in large increments. Starkie (2023) challenges this perspective, arguing that capacity can be added incrementally, for example through the addition of aprons. He also notes that terminals could be built modularly, allowing for flexible use. Independently, a large investment challenges efficiency estimation because airports are likely to appear inefficient immediately after expansion and until the new capacity is fully utilised.

2. The prices are adjusted in accordance with an increase in the consumer (CPI) or retail price index (RPI) minus the X term, which accounts for the expected efficiency improvement of the firm.
3. Ramsey pricing sets charges based on demand elasticity, allowing firms to exceed marginal cost where appropriate. This maximises social welfare while ensuring fixed cost recovery.
4. Allocative efficiency refers to the alignment of prices with social marginal costs, ensuring welfare-maximizing resource allocation. For efficient pricing of scarce capacity, external delay costs must be incorporated so that prices equal social marginal costs.
5. Note that Assaf et al. (2014) explicitly state that price-cap regulation improves technical efficiency.
6. Classifying price-cap versus cost-based regulation is not straightforward because hybrid forms of regulation are commonly practiced (Adler et al., 2015). Unfortunately, neither study specifies how the airports were classified.
7. It should be noted that through capacity management, slot regulation can improve allocative efficiency but not technical efficiency which relates to the use of factors of production.
8. An avenue for further research is the analysis of the efficiency of the use of the runway and its link to airport pricing.

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Appendix: Overview of research on airport performance and charges

Reference	Region	Inputs	Outputs	Results
Positive effects				
Oum et al. (2004)	Asia Pacific, North America and Europe	Capital, labour, soft-costs	Passengers, aircraft movements, non-aeronautical revenues	Total factor productivity highest at airports with dual-till price-cap
Assaf (2010)	Australia	Price of labour & capital	Passengers, cargo, aircraft movements	Light-handed regulation leads to cost efficiency
Assaf et al. (2012)	UK	Price of labour, capital & materials	Total revenues	Price-cap regulated airports are more cost efficient
Bottasso and Conti (2012)	UK	Capital stock, price of labour & variable inputs	Work load units, aircraft movements, non-aeronautical revenues	Regulation increases technical efficiency
Curi et al. (2011)	Italy	Operational: labour, number of runways, apron size Financial: labour costs, other costs, airport area	Operational: passengers, cargo, aircraft movements Financial: aeronautical & non-aeronautical revenues	Dual-till price caps improve financial efficiency but operational efficiency drops
Adler et al. (2015)	Europe and Australia	Labour, other operating costs, runway capacity	Non-aeronautical revenues, passengers, aircraft movements, cargo	Incentive-based regulation leads to higher productive efficiency compared to cost-plus
Adler and Liebert (2014)	Europe and Australia	Staff costs, other operating costs, declared runway capacity	Passengers, cargo, aircraft movements, non-aeronautical revenues	Under weak competition, privately-owned, dual-till price-cap regulated airports are more efficient than unregulated

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Reference	Region	Inputs	Outputs	Results
				counterparts Under competition, unregulated public and private airports operate equally cost efficiently
Karanki and Lim (2020)	United States	Labour, number of runways, land area, gates, variable costs	Work load units, non-aeronautical revenues	Compensatory and hybrid agreements positively impact efficiency
Cambini and Congiu (2022)	Italy	Price of capital, labour, services and materials	Aircraft movements, commercial revenues	Dual-till price-cap regulation with negotiation reduces average costs
Valdes et al. (2024)	Mexico	Runway capacity, labour, terminal size	Passengers, cargo, aircraft movements	Dual-till revenue cap increases productive efficiency
No effects				
Randrianarisoa et al. (2015)	Europe	Labour, soft-costs	Passengers, aircraft movements, non-aeronautical revenues	No significant difference in operating efficiency of airports due to regulation
Negative effects				
Assaf and Gillen (2012)	Europe, North America and Australia	Labour, soft costs, number of runways, size of passenger terminals	Passengers, aircraft movements, non-aeronautical revenues	Private airports subject to minimal economic regulation are most efficient Government-owned, single-till, cost-based regulation is least efficient
Assaf et al. (2014)	Europe, North America and Australia	Employees, materials & contracted services, runways, terminal area, price of labour	International passengers, other passengers, aircraft movements, non-aeronautical revenues	Economic regulation reduces short run technical efficiency
See and Li (2015)	UK	Labour, capital stock, other operating expenses	Aeronautical & non-aeronautical revenue	Regulated airports attain lower productivity growth than unregulated airports
Impact of regulation on charges				
Bel and Fageda (2010)	Europe	Independent variables: price-cap & dual-till dummy	Dependent variable: price	Type and scope of regulation has no significant effect on charges Unregulated private airports set higher charges than their public or regulated counterparts
Bilotkach et al. (2012)	Europe	Independent variables: price-cap, single-till & ex post regulation dummy	Dependent variable: aeronautical revenue per aircraft movement	Single-till regulated airports impose lower charges than dual-till regulated airports Type of regulation has no significant effect on charges
Adler and Liebert (2014)	Europe and Australia	Independent variables: interaction between runway utilisation and price-cap dummies	Dependent variable: aeronautical revenues	Unregulated private airports impose higher charges than their public counterparts
Conti et al. (2019)	Europe	Independent variables: interaction between passenger threshold and EU directive adopted by national law	Dependent variable: airport charges	EU Airport Charges Directive led to lower charges subsequently