Is aiming up on the WACC beneficial to customers?

Prepared for Heathrow Airport Limited

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Final

1 Purpose of this note

In March 2018, the UK Regulators Network (UKRN) published a paper on the estimation of the cost of capital for the purposes of price controls in the UK.[1] One of the issues discussed in the paper was the question whether it is optimal and desirable for a regulator to set the allowed return above the midpoint estimate of the WACC (i.e. to 'aim up').

The paper concluded that 'the optimal choice of the RAR [regulatory allowed return] […] is high, in terms of the percentile within the range of distribution of the true WACC'.[2]

In reaching this conclusion, the author assumed that 'the consequence of setting too low a RAR [regulatory allowed return] is a complete loss of investment',[3] which is, arguably, an extreme assumption.

The purpose of this note is to examine whether the conclusions in the UKRN paper still hold if this assumption is relaxed.

2 Conceptual framework

In deciding to what extent, if at all, to aim up on the WACC, regulators are trying to balance the risk of potentially overcharging customers on the one hand, and the risk of the company not being able to carry out its investment programme on the other. In the latter case, customers will not be able to enjoy the same quality of service. The higher the potential loss in quality of service, the higher the regulator should aim up.

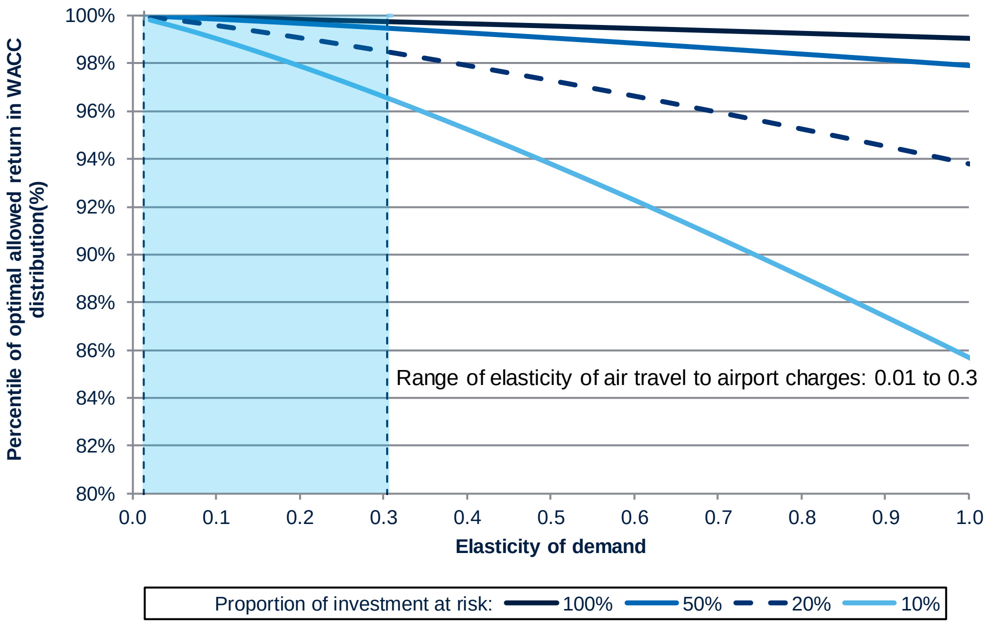
[1] UKRN (2018), 'Estimating the cost of capital for implementation of price controls by UK regulators', 6 March.
[2] Ibid, p. 163.
[3] Ibid.

Our extension of the approach in the UKRN paper suggests that in the case of airport charges:

- even with a low proportion of investment at risk, aiming up on the WACC is still likely to be in customers' interests;
- the lower the price elasticity of demand, the higher the 'safety cushion' between the allowed return and the central estimate of WACC should be;
- for realistic values of the price elasticity, customer welfare is maximised by setting the allowed return at or above the 96th percentile of the WACC distribution.

Figure 2.1 illustrates the optimal level of allowed return under different levels of price elasticity and potential proportion of investment lost, assuming WACC is normally distributed. The other underlying modelling assumptions are described in section 3.

Figure 2.1 Optimal allowed return



Note: See the next section for more details on the modelling assumptions.

Source: Oxera analysis, based on UKRN (2018), 'Estimating the cost of capital for implementation of price controls by UK regulators', 6 March and PwC (2019), 'Estimating the cost of capital for H7—Response to stakeholder views', February, p. 14.

3 Modelling assumptions

3.1 Conceptual setup

Our analysis assumes that in setting the allowed return, the regulator seeks to minimise expected losses to customers. The loss can materialise in two ways:

- if the regulator sets the allowed return above the true WACC, then the loss to customers is the difference in welfare under the current price level and the lower price level that they would have enjoyed, had the regulator set the WACC at its true (lower) level;

- if the regulator sets the allowed return below the true WACC, there is a risk of underinvestment, and the loss to customers is equal to a fraction of the welfare that they would have enjoyed, had the WACC been set at its true value and the optimal level of investment had occurred.

Note that since the true level of WACC is unobservable, the regulator cannot expect its best estimate of WACC to be exactly equal to the true value of WACC. Given this uncertainty, the regulator seeks to minimise the expected loss that can occur to customers. Mathematically, this can be expressed in the following manner:

$$L(x,y) = \int_{-\infty}^{x} \big(W(y) - W(x)\big) f(y)dy + \int_{x}^{+\infty} \alpha W(y) f(y)dy$$

Where:

$L(x,y) - expected\ loss\ to\ consumers$

$x - allowed\ return\ set\ by\ the\ regulator$

$y - true\ WACC\ of\ the\ firm, distributed\ with\ a\ pdf\ of\ f(y);$
$in\ line\ with\ the\ UKRN\ approach, this\ note\ assumes\ that\ f(y)\ is\ a\ normal$
$distribution\ with\ a\ mean\ of\ 5\%\ and\ a\ standard\ deviation\ of\ 1\%$

$\alpha - share\ of\ investment\ which\ will\ not\ be\ undertaken\ if$
$the\ allowed\ return\ (x)\ is\ set\ below\ the\ true\ value\ of\ WACC\ (y)$

$W(x) - consumer\ welfare\ with\ the\ allowed\ return\ set\ to\ x$

$W(y) - consumer\ welfare\ with\ the\ allowed\ return\ set\ to\ the\ true\ value$
$of\ WACC\ (y)$

In line with the approach of the UKRN paper, we use customer surplus as a proxy for the welfare function. In this note, we have used the semi-log functional form of demand:

$$D(p) = ae^{-bp}$$

Similarly, following the approach in the UKRN paper, we assume that the regulated price (p) is a linear function of the allowed return (x):

$$p = \frac{c}{k} + x$$

Where:

$x - allowed\ return\ set\ by\ the\ regulator$

$c - marginal\ operating\ cost$

$k - per\ unit\ cost\ of\ capacity$[4]

Note that for the purposes of the analysis it is not necessary to define the individual values of c and k; it is sufficient to define the ratio of the two.

[4] This wording is taken verbatim from the UKRN paper. Conceptually, k can be thought of as the asset base, divided by the volume of goods, produced by the regulated firm. The ratio of c to k can therefore be proxied as a ratio of OPEX to RAB.

3.2 Values of input parameters

While in this analysis we follow the framework of the UKRN paper, where possible, we have updated the parameter values to reflect the updated market evidence. In cases where the UKRN paper did not disclose the parameter values it relied upon, we have examined a range of values to ensure that we capture the full range of plausible outcomes. Table 3.1 presents the parameter values adopted in this modelling.

Table 3.1 Parameter values assumed in the modelling

Parameter	Assumed value	Comment
WACC distribution		
Expected WACC	2.9%	This is based on the range of 2.5–3.4%, as estimated by PwC in the report for the CAA. It is assumed that the midpoint of the range corresponds to the expected value.
Standard deviation of WACC	0.2%	It is assumed that the range estimated by PwC spans four standard deviations.
Demand and customer welfare function		
α	100%-10%	Proportion of investment at risk. UKRN effectively assumes an α of 100%.
b	0.25-12.25	UKRN study does not disclose the assumption used for this parameter, so a broad range of values was assumed. This range, in combination with the parameters below, implies demand elasticities from 0.03 to 1.14.
Regulatory price		
c	0.05	As per UKRN.
k	1	The UKRN study does not disclose the assumption used for this parameter. We have assumed a value of 1, as it appears to be approximately in line with the information from the latest Heathrow accounts.[1] Note, this parameter does not affect the optimal allowed return—it only affects the elasticity.

Note: [1] In particular, in 2019 the adjusted operating expenditure for Heathrow amounted to £1,149m and the RAB amounted to £16,598m. Therefore, the ratio of the two amounts to 0.07, which is close to the c/k ratio of 0.05 assumed in this analysis. All else equal, assuming a c/k ratio of 0.07 will imply a higher optimal allowed return for a given value of elasticity demand. See Heathrow (SP) Limited (2020), 'Annual report and financial statements 2019'.

Source: Oxera analysis based on UKRN (2018), 'Estimating the cost of capital for implementation of price controls by UK regulators', 6 March and PwC (2019), 'Estimating the cost of capital for H7—Response to stakeholder views', February, p. 14.

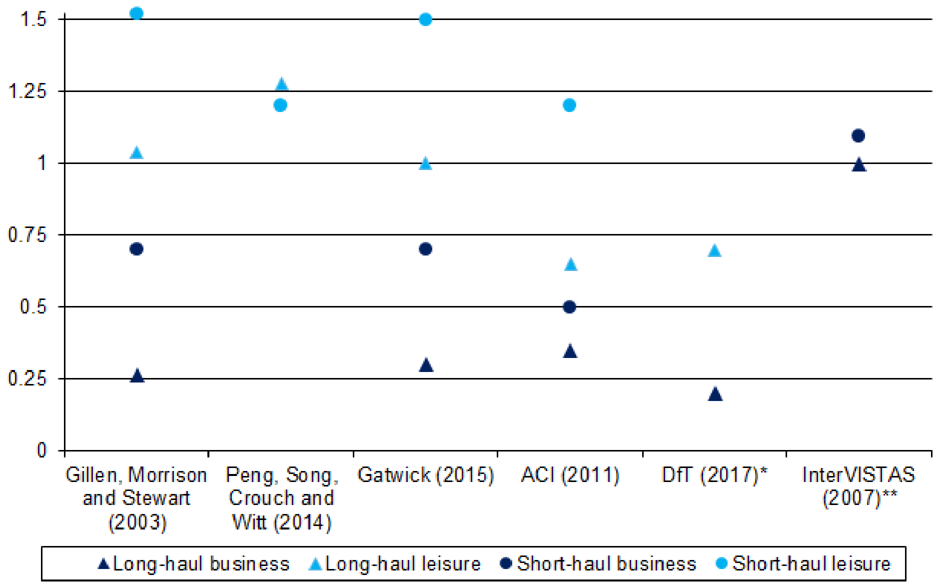
3.3 Relevant demand elasticities

As illustrated in Figure 2.1, the magnitude of optimal allowed return varies with the elasticity of demand. The lower the demand elasticity, the higher should be the optimal allowed return relative to the central estimate of WACC.

Empirical studies suggest that the price elasticity of air travel ranges from 0.2 to 1.52,[5] as illustrated in Figure 3.1.

[5] The elasticities are quoted in absolute value terms.

Figure 3.1 Price elasticity of air travel



Notes: * This study does not distinguish between long and short haul. **This study does not distinguish between business and leisure travel.

Source: Oxera analysis based on the following empirical studies: Gillen, D.W., Morrison, W.G. and Stewart, C. (2003), 'Air travel demand elasticities: concepts, issues and management', Department of Finance, Government of Canada, January; Peng., B., Song, H., Crounch, G.I. and Witt, S.F. (2015), 'A meta-analysis of international tourism demand elasticities', *Journal of Travel Research*, **54**:5, pp. 611–33 and 625; Gatwick Airport Limited (2015), 'Traffic, Capacity and Competition Evidence: Report for the Airports Commission', February; Airport Council International (2011), 'ACI Airport Traffic Forecasting Manual: A practical guide addressing best practices', June; Department for Transport (2013), 'UK Aviation Forecasts', January; InterVISTAS (2007), 'Estimating Air Travel Demand Elasticities Final Report', prepared for IATA, December.

Given that the airport charges constitute between 7% and 20% of a typical airline ticket,[6] the elasticity of air travel with respect to airport charges ranges from 0.001 to 0.3. This in turn implies that the regulator should set the allowed return above the 96th percentile of the WACC distribution, as illustrated in Figure 2.1.[7]

4 A note on sunk investments

All of the analysis outlined above concerns potential future investment. UKRN's analysis suggests that in case of investment that has already been carried out, it is optimal 'to ensure the lowest possible regulated price and therefore highest possible customer surplus'.[8] Given the financeability requirements, UKRN concludes that 'the optimal RAR [regulatory allowed return] [...] for old (sunk) investment is therefore the expected WACC'.[9]

This conclusion, however, assumes that no future investment is required.

[6] See InterVISTAS (2018), 'The impact of airport charges on airfares', Prepared for Australian Airports Association, p.ii; Civil Aviation Authority (2014), 'Market power determination for passenger airlines in relation to Stansted Airport – statement of reasons', January, p.41
[7] We have also examined a sensitivity where WACC is uniformly distributed between 2.5% and 3.4%, as per PwC analysis. This assumption implies that for the relevant level of elasticities it is always optimal to set the allowed return at the top end of the range,
[8] UKRN (2018), 'Estimating the cost of capital for implementation of price controls by UK regulators', 6 March, p. 164.
[9] Ibid.

However, in a world where companies are considering potential capacity expansions to their existing assets or construction of greenfield assets, regulatory treatment of sunk investment can affect future projects as well.

All else equal, if investors learn that the regulator intends to aim up during the first regulatory period only, they will expect lower cash flows over the lifetime of the project. This, in turn, decreases the attractiveness of the project and could in some cases jeopardise its economic viability.

5 Mathematical derivation

This section presents the mathematical derivation of the optimal allowed return.

The regulator seeks to minimise the following loss function:

$$L(x) = \int_{-\infty}^{x} \big(W(y) - W(x)\big) f(y)dy + \alpha \int_{x}^{+\infty} W(y)f(y)dy$$

Where:

$x - allowed\ return\ set\ by\ the\ regulator$

$y - true\ WACC\ of\ the\ firm,$

$f(y) - probability\ density\ function\ of\ y$

$F(y) - cumulative\ density\ function\ of\ y$

$\alpha - share\ of\ investment\ which\ will\ not\ be\ undertaken\ if$
$the\ allowed\ return\ (x)\ is\ set\ below$
$the\ true\ value\ of\ WACC\ (y)$

$W(x) - consumer\ welfare\ with\ the\ allowed\ return\ set\ to\ x$

$W(y) - consumer\ welfare$
$with\ the\ allowed\ return\ set\ to\ the\ true\ value\ of\ WACC\ y$

The interpretation of the first term of the loss is as follows: if the allowed return (x) is set above the true WACC (y), customer loss equals the additional welfare that customers would have enjoyed if the regulator perfectly predicted the WACC (and thus set the allowed return x equal to y).

The interpretation of the second term of the loss is as follows: if the allowed return (x) is below the true WACC (y), not all of the planned investment can be carried out. As a result, customers will not enjoy the originally expected level of service. Therefore, customers lose a fraction (α) of the welfare they would have enjoyed had the regulator perfectly predicted the WACC (and thus set the allowed return x equal to y).

Employ Leibniz's differentiation rule under the integral sign to obtain

$$\frac{dL}{dx} = -\frac{dW(x)}{dx} F(x) - \alpha W(x) f(x)$$

Thus, the first order condition for a local minimum at $x = x^*$ is

$$-\frac{\frac{dW(x^*)}{dx}}{W(x^*)} = \frac{\alpha f(x^*)}{F(x^*)}$$

In line with the approach in the UKRN paper, assume that the welfare function equals customer surplus:

$$W(x) = CS\big(p(x)\big) = \int_{p}^{+\infty} D(z)dz$$

Differentiate the welfare function with respect to x:

$$\frac{dW}{dx} = \frac{dCS}{dx} = \frac{\partial CS}{\partial p}\frac{dp}{dx} = \frac{\partial}{\partial p}\left(\int_{p}^{+\infty} D(z)dz\right)\frac{dp}{dx} = -D(p)\frac{dp}{dx}$$

and write the first order condition:

$$\frac{D(p)\frac{dp}{dx}}{W(x^*)} = \frac{\alpha f(x^*)}{F(x^*)}$$

Assuming that the demand function is semi-log, write:

$$\frac{D(p)\frac{dp}{dx}}{W(x^*)} = b\frac{dp}{dx}$$

Assuming, as per the approach in the UKRN paper, a one-to-one sensitivity of prices to allowed return, we get:

$$b = \frac{\alpha f(x^*)}{F(x^*)}$$

Note that the above expression contains the cumulative distribution function of the random variable y. If the distribution $F(y)$ is assumed to be normal, as per UKRN's approach, the equation does not have a closed-form solution. In other words, the equation cannot be further simplified in general terms and has to be solved numerically for a concrete value of b.